

THE WATER QUALITY
OF
LAKE NOSBONSING
NIPISSING DISTRICT
1975 - 1980

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NIPISSING DISTRICT
1975 - 1980

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Northeastern Region,
1983.

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INTRODUCTION

Lake Nosbonsing is an important recreational waterbody near North Bay in Northeastern Ontario.

In response to local concerns regarding existing water quality and the potential effects of continuing shoreline development pressure, the Ministry of the Environment initiated an investigation of water quality in 1975 which was continued through 1980. The most comprehensive work was undertaken during the summer of 1975 when water chemistry, microbiological water quality and physical lake conditions were evaluated. In that same year, a pollution survey of shoreline housing units was also undertaken.

As a result of the findings of the original surveys, many new waste disposal systems (septic tanks and tile beds) were installed and many others were repaired in an attempt to correct the identified problems. During 1979, a repeat pollution survey of tourist operations bordering the lake showed a significant upgrading of sewage disposal systems over 1975 conditions; however, 12 problem areas still existed. Commitments to bring the offending systems into conformity with Provincial regulations during the 1980 construction season were secured from the owners. All of the corrective work was completed as scheduled.

The identification of puzzling water quality conditions led to continued testing of the water to obtain a better record of what was occurring in Lake Nosbonsing from year to year.

This report reviews and summarizes the water quality investigations that have been conducted since 1975. It provides a lake quality classification based on test results and presents a phosphorus budget for the lake. The potential effect of additional shoreline housing development on the phosphorus budget and the expected impact on the existing water quality are also examined.

CONCLUSIONS AND RECOMMENDATIONS

During the 1975 to 1980 monitoring period, the water quality of Lake Nosbonsing was generally fair to poor according to the indicator parameters investigated.

Water chemistry monitoring revealed the presence of moderate to high concentrations of the nutrient elements phosphorus and nitrogen which can be responsible for the occurrence of nuisance algae and aquatic weed growths. Other chemical parameters were present in low to moderate concentrations in the surface waters.

The values of pH (lake acidity) remained within the biologically favourable 6.5 to 8.5 unit range while alkalinity (a measure of buffering capacity against the effects of acidic inputs) was good.

Dissolved oxygen and temperature profiles developed in 1975 and 1979 showed no significant changes. Distributions of dissolved oxygen in the deeper thermally stratified basins displayed the undesirable pattern associated with nutrient enriched (eutrophic) conditions. In addition, deep water oxygen concentrations were well below the desired Provincial Water Quality Objectives for warm water biota.

The chemical composition of near-bottom waters was also poor. Build-ups of iron concentrations above the limits of the Provincial Objectives and high concentrations of the nutrient elements phosphorus and nitrogen were apparent.

Analyses for metals which can be toxic to aquatic lifeforms when present in high concentrations, revealed quantities generally below the detection limits of the analytical methodologies.

Water clarity was low to moderate while average chlorophyll a concentrations were high, showing an order of primary biological activity associated with the poor water quality of nutrient enriched lakes.

Microbiological surveys of Lake Nosbonsing revealed that the water quality was good and within the limits of the Ministry of the Environment's Objectives for recreational and body contact use. The influence of shoreline development and human activity on the lake was measured and increased bacterial densities were noted near Astorville and Bonfield.

Population densities of bacteria were within the range normally found in good quality surface waters. However, due to the isolation of total coliform, fecal coliform and fecal streptococcus groups it is recommended as it is for all surface waters, that untreated lake water not be used as a drinking supply.

The measurement of springtime phosphorus concentrations since 1975 allows classification of the area west of Shields Point as a mid Level 3 waterbody while the main body of the lake appears to be in the early Level 3 category.

Monitoring of inflowing stream phosphorus concentrations and subsequent theoretical modeling of the lake's phosphorus budget failed to account for the higher phosphorus concentrations measured in the Astorville basin. For the larger eastern end of Lake Nosbonsing, theoretical modeling of phosphorus inputs via inflowing streams was reasonably successful in predicting lake phosphorus values.

Phosphorus budgets are used to predict the effects of additional shoreline development on the existing water quality. However, because of the Level 3 (fair) classification of Lake Nosbonsing and the presence of conditions associated with water quality problems, it is recommended that no new lots be created along the shoreline of the lake.

The goal of the Ministry of the Environment is to ensure that the surface waters of the Province are of a quality which is satisfactory for aquatic life and recreation. Lakes falling into the Level 1 (excellent) and Level 2 (good) classifications satisfy the requirements of the goal statement. In order to satisfy the objectives of the goal, the Northeastern Region of the Ministry of the Environment recommends that:

- a) water quality be maintained within the existing trophic status classifications (Level 1 or Level 2).
- b) water quality deterioration not be allowed beyond the Level 2 classification.

Due to the Level 3 classification of the Astorville basin, the apparent Level 3 classification of the main part of Lake Nosbonsing and the presence of conditions associated with water quality problems (high chlorophyll, low dissolved oxygen), IT IS RECOMMENDED THAT NO NEW WATERFRONT LOTS BE CREATED . IT IS ALSO RECOMMENDED THAT ALL NEW CONSTRUCTION ON EXISTING LOTS BE KEPT BACK A DISTANCE OF 30 METRES (100 FEET) FROM THE HIGH WATER LINE TO REDUCE NUTRIENT LOADINGS WHICH COULD LEAD TO FURTHER DETERIORATION OF WATER QUALITY.

IN ADDITION, IT IS RECOMMENDED THAT THE OWNERS OF PROPERTY BORDERING ON LAKE NOSBONSING BE REQUESTED TO RETAIN THE LANDS BETWEEN THEIR BUILDINGS AND THE WATERS EDGE IN AS NATURAL A STATE AS POSSIBLE IN ORDER TO RETARD THE ACCESS OF NUTRIENTS.

SECTION 1:

STUDY AREA DESCRIPTION

Lake Nosbonsing is a relatively shallow waterbody located approximately 20 kilometres southeast of the City of North Bay . The lake is accessible from either highway 11 or 17 (Figure 1).

Lake Nosbonsing is a headwater lake of the scenic Mattawa River system and flows via the Kaibuskong River to Lake Talon and ultimately to the Ottawa River. The major inflow is the Nosbonsing River which empties into the lake near the mid-point of the south shore. There are numerous smaller inlets scattered about the lake perimeter, the majority occurring along the south shore. The only outlet is the Kaibuskong River at the east end of the lake.

The topography of the Lake Nosbonsing drainage basin is dominated by high Precambrian Hills, overlain with thin glacial deposits and strewn with large granitic boulders.

The physical characteristics of Lake Nosbonsing are listed below:

Watershed Area	12087.10 hectares
Surface Area	1719.35 hectares
Mean Depth	5.5 metres
Maximum Depth	14.0 metres
Volume	9.456×10^7 cubic metres



Ministry of the Environment, Northeastern Region

GEOGRAPHIC LOCATION, LAKE NOSBONSING, NIPISSING DISTRICT

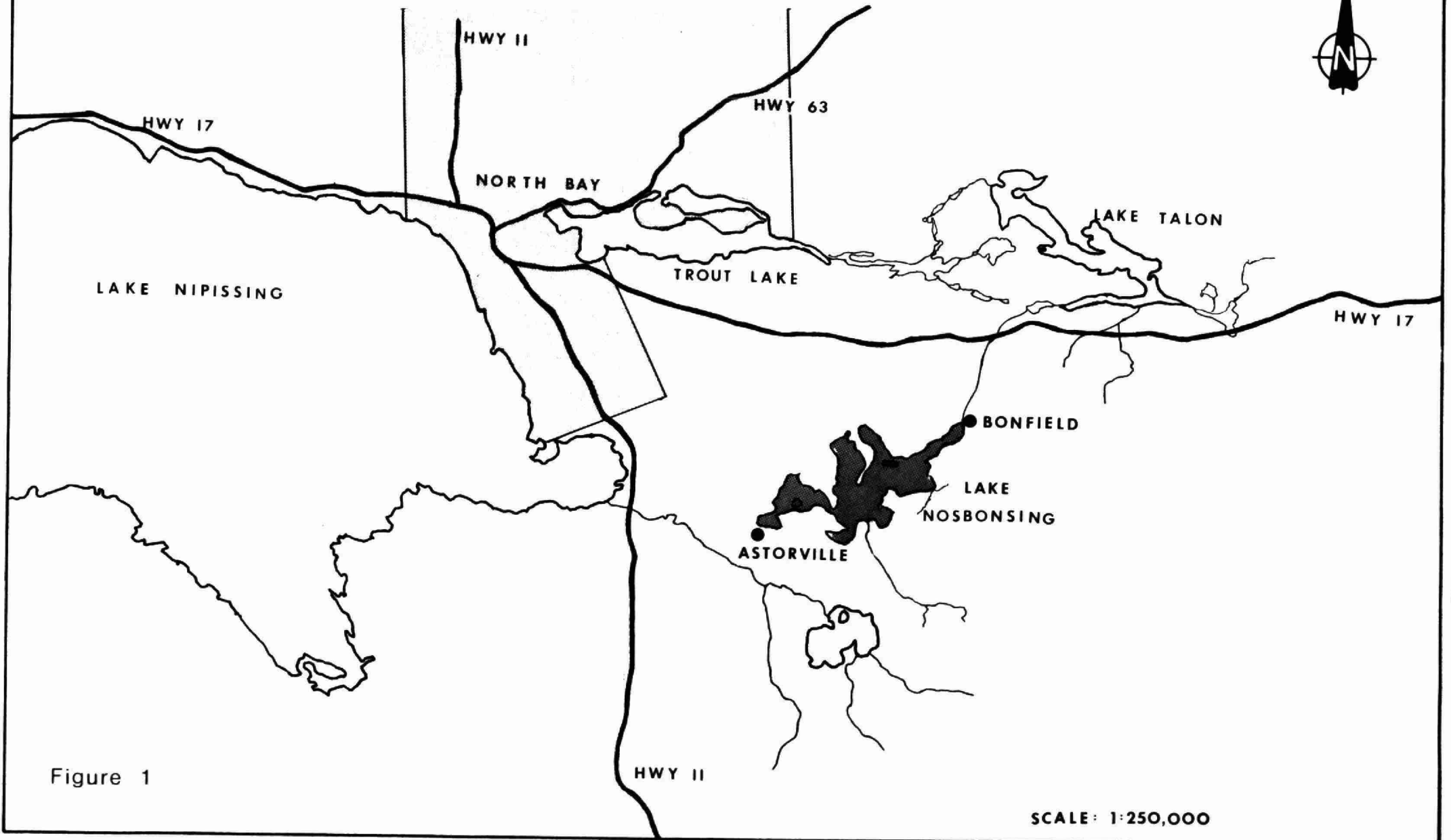


Figure 1

Land use in the area surrounding the lake is dominated by a mixture of seasonal-recreational and residential housing. There is a continuing trend of upgrading of cottages for year-round residential use.

Ministry of Natural Resources survey data from 1975 indicated that 72 permanent dwellings and 408 seasonal dwellings were fronting the water's edge. This number included 15 commercial establishments (tourist operations, marinas). There were an additional 121 permanent, 18 seasonal dwellings and 5 business establishments located within 300 metres of the shoreline which were considered "significant" in terms of potential water quality impact due to the steep gradient toward the lake.

Within the watershed, a greater proportion of land adjacent to the lake has been cleared along the north shore. Agricultural usage appears to be restricted to unimproved pastureland. South of the lake, cleared land previously used for agriculture has been converted to seasonal and year-round residential use. Some hobby farms still remain.

Lake Nosbonsing is designated as a warm water fishery. The primary sport fish are walleye, smallmouth bass, muskellunge, northern pike and yellow perch. Other species present are rock bass, pumpkinseed sunfish and lake herring.

Summer recreational activities on Lake Nosbonsing include boating, fishing, waterskiing and swimming. During the winter, icefishing and snowmobiling are the main activities.

SECTION 2:

SURVEY PROCEDURES

2.1 GENERAL WATER CHEMISTRY:

The chemical water quality of Lake Nosbonsing was investigated on a number of occasions. Up to six stations were sampled during surveys conducted in 1975, 1978, 1979 and 1980.

Water samples were obtained early in the spring to take advantage of the uniform distribution of chemical constituents which exists throughout the lake prior to surface heating and increasing biological activity.

Composite samples of the euphotic zone (the depth of light penetration effective for the growth of aquatic plants and algae) were obtained in May of 1975, 1979 and 1980. In June, July and August 1975, August 1978, and July and August 1979, water samples for chemical analysis were obtained through the euphotic zone and one metre off the bottom of the deeper sampling locations, designated as stations 2, 3, 4, 5 and 6 in Figure 2.

The determination of the chemical water quality involved the evaluation of the concentrations and distribution of the following parameters:

hardness	total phosphorus
alkalinity	total Kjeldahl nitrogen
pH	ammonia
conductivity	nitrite
colour	nitrate
calcium	organic carbon
magnesium	inorganic carbon
sulphate	iron
chloride	

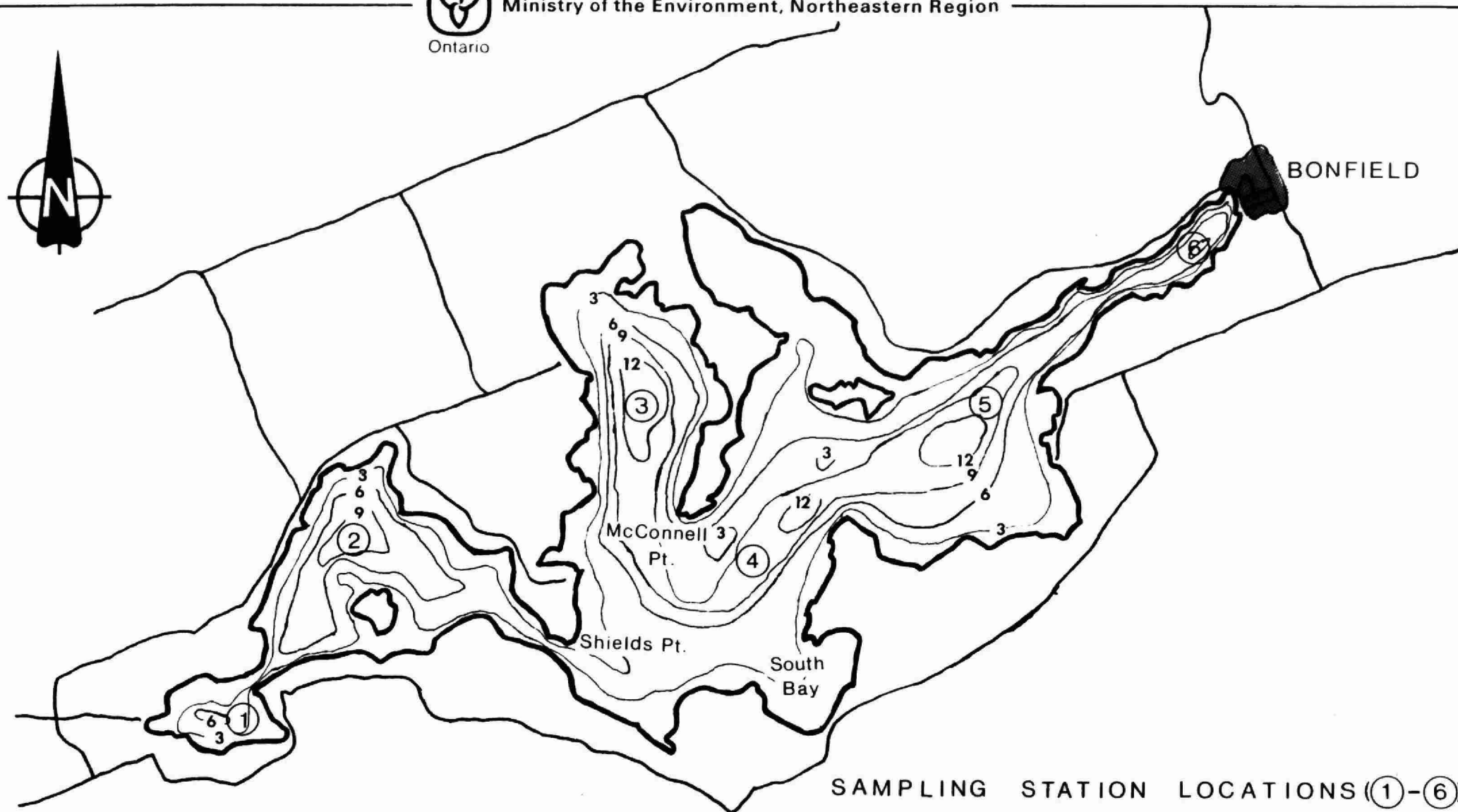


Figure 2

CONTOUR INTERVALS IN METRES



SAMPLING STATION LOCATIONS (1)-(6)

LAKE NOSBONSING 1975-1980

SCALE: 1:50,000

2.2 METALS:

- (a) Due to the relative proximity of the Sudbury smelting operations, and the concern for metallic inputs from atmospheric fallout, the presence of metals with potential toxicity to aquatic lifeforms was investigated.

In June of 1979, sampling was conducted for the presence of copper, nickel, lead, zinc, cadmium, chromium and aluminum.

2.3 SPRING PHOSPHORUS:

The determination of the phosphorus concentration of a water body is an indication of overall recreational water quality. Development of a phosphorus budget for a lake can be used to predict the water quality changes likely to occur following the addition of shoreline housing units (Dillon and Rigler, 1975).

Sampling was conducted in 1975, 1979 and 1980 to determine the amount of phosphorus present during spring turnover when the lake is completely mixed. The results were used to develop a phosphorus budget.

2.4 TROPHIC STATUS:

Indications of lake trophic status (degree of nutrient enrichment) and water quality were also obtained from the investigation of biological and physical conditions.

Water transparency or clarity, was measured with a Secchi disc on twelve separate occasions from 1975 to 1980. The disc (20 cm diameter metallic plate printed in alternating black and white quadrants) was lowered into the water until it disappeared from view.

Primary biological activity was evaluated by measuring the concentration of chlorophyll a (the green pigment of algae) in the euphotic zone.

2.5 DISSOLVED OXYGEN AND TEMPERATURE.

The mid to late summer vertical distributions of dissolved oxygen and water temperature are used to explain many of the conditions encountered and to estimate the potential for the occurrence of specific water quality problems.

Dissolved oxygen and temperature profiles were developed at one metre intervals during the 1975 and 1979 sampling surveys, using a Model 54 Y.S.I. combination oxygen-temperature meter.

All chemical, metal and chlorophyll a analyses were done at the Ministry of the Environment Laboratory in Toronto, according to published methods (MOE 1981).

2.6 MICROBIOLOGICAL WATER QUALITY:

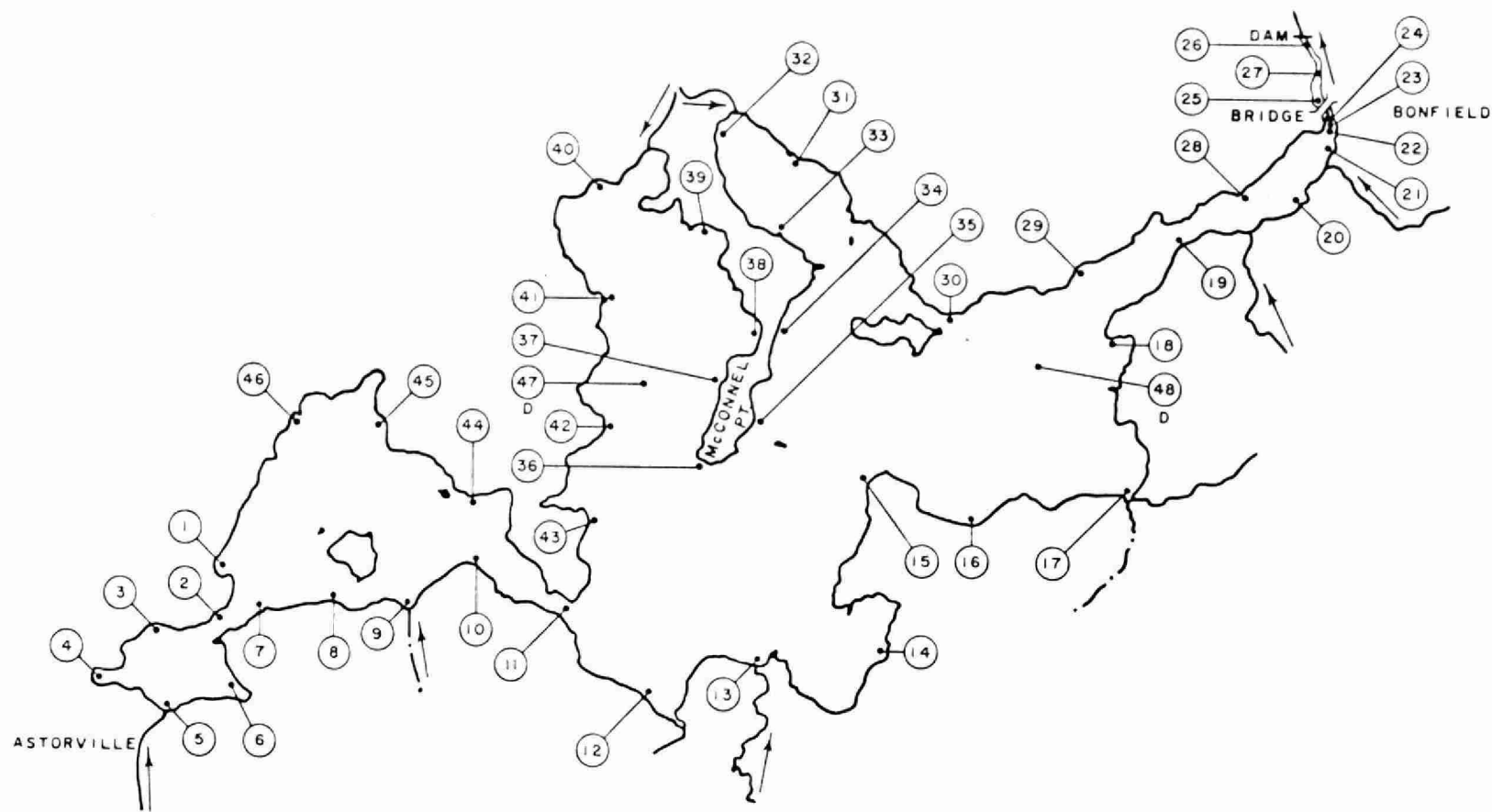
Three five-day microbiological surveys were conducted during the 1975 intensive sampling period. Surveys were scheduled between May 29 and June 2, July 3 and 7, and August 7 and 11.

The microbiological sampling stations were situated in areas considered to be representative of the various degrees of shoreline development and at locations of water inflow and outflow.

A total of 46 sampling stations were established along the shoreline. Two mid-lake and two depth stations were added to complete the microbiological evaluation (Figure 3).

Samples were collected seven to ten metres from the shore and one metre below the surface at the shoreline and mid-lake stations. At the depth stations, water samples were taken one metre from the lake bottom.

Once obtained, the presterilized polycarbonate bottles holding the samples were stored on ice and transported to the mobile laboratory where they were analyzed within 2 to 6 hours of collection.



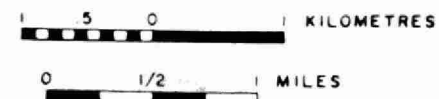
LEGEND

⑦ — BACTERIOLOGICAL SAMPLE

LAKE NOBSONG

LOCATION OF BACTERIOLOGICAL SAMPLING STATIONS

Figure 3



2.7 INFLOWING STREAM CHEMISTRY:

Due to the presence of consistently high nutrient concentrations in Lake Nosbonsing, the possible sources of enrichment were investigated through an inflowing stream monitoring program conducted during 1980.

Water samples were obtained from the inflows shown in Figure 4. The major inflows (NL-2,5,7,8,9) were sampled at weekly intervals in April and May during the period of maximum runoff, and once a month thereafter until sampling was terminated in mid-September. The minor inflows (NL-1,5,6,7) were sampled during peak flows in April.

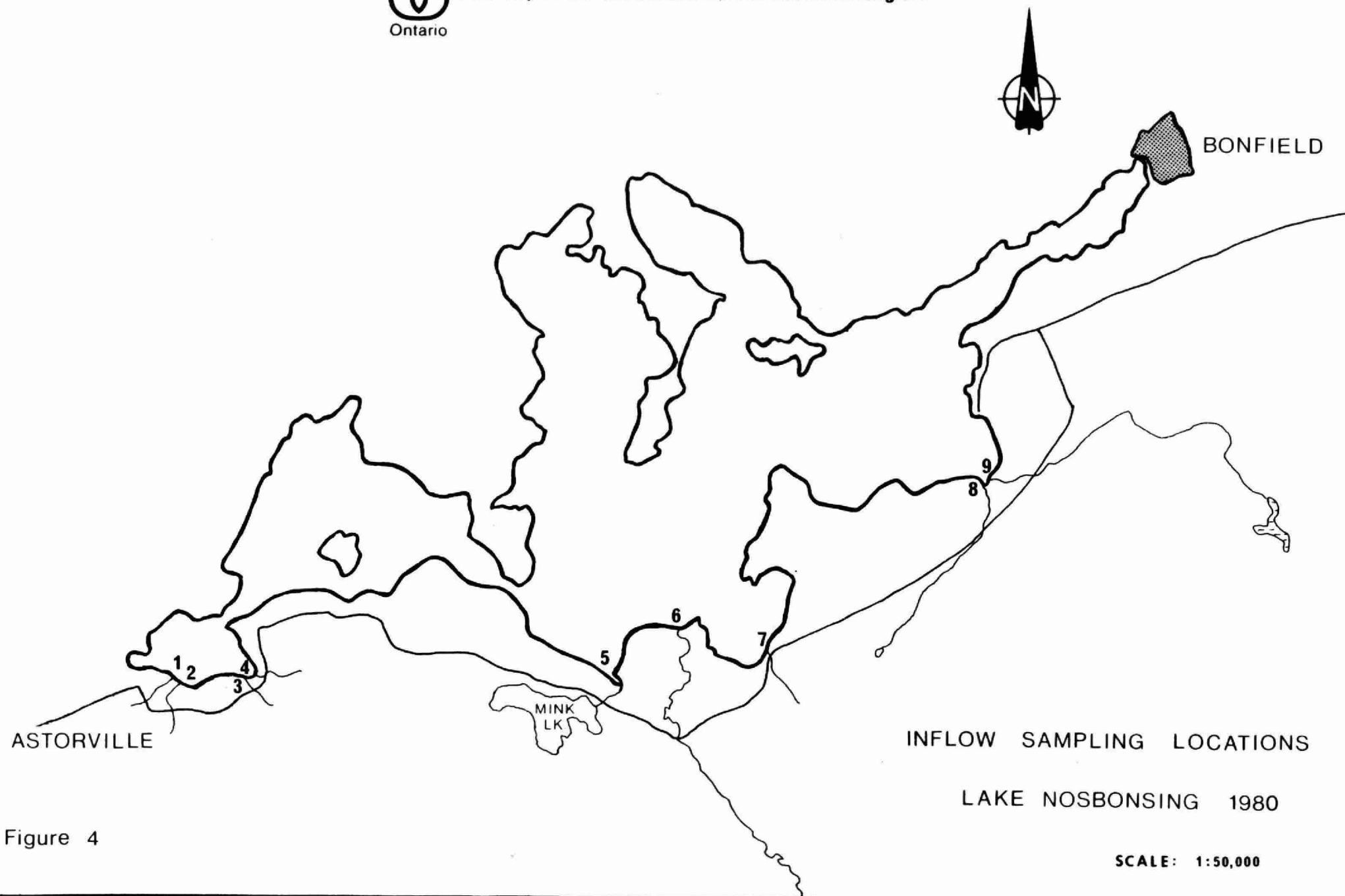


Figure 4

SECTION 3:

SURVEY RESULTS

3.1 GENERAL WATER CHEMISTRY:

Results of chemical analyses for samples obtained in June, July and August of 1975, August 1978, and June and August of 1979 are tabulated in Appendix A, B and C respectively. Data are included for composite samples taken at Station 1 and for composite samples and samples collected one metre off the bottom for stations 2 through 6.

3.1.1 Calcium, Magnesium and Hardness:

Hardness is defined as the soap consuming ability of water. In Lake Nosbonsing, concentrations of hardness and its two principal component ions, calcium and magnesium, remained relatively constant and uniformly distributed throughout the water column. Hardness values during the three years of sampling ranged from a low of 19 mg/L, to a high of 30 mg/L. Generally, concentrations between 22 and 25 mg/L prevailed. The lake water can be classified as moderately soft.

Calcium and magnesium concentrations were determined in 1978 and 1979. Calcium ranged from 5.8 to 7.2 mg/L while magnesium ranged from 1.55 to 1.95 mg/L.

3.1.2 Conductivity:

Conductivity is a measure of the ability of water to pass an electric current and is used as an indication of the quantity of dissolved substances.

Measured values remained reasonably uniform in both surface composite and near-bottom samples over the 1975-1979 sampling period. A range of values between 59 and 79 umhos/cm was recorded.

The distribution of conductivity readings for Lake Nosbonsing indicated that there were differences between the water chemistry of the basins west of McConnell Point (Stations 1 and 2) and the eastern portion of the lake. Conductivity values in the Astorville basin (Stations 1 and 2) were consistently higher than at the other sampling locations by approximately 4 to 7 umhos/cm. Build-ups of dissolved substances were apparent in the bottom waters of the deeper sampling stations. In particular, the highest conductivities were recorded in the bottom samples obtained at Station 2.

The other station where thermal stratification was persistent (Station 3) also revealed a tendency to increased conductivities in the bottom waters.

3.1.3 Alkalinity:

Alkalinity is a measure of a water's ability to resist a pH change from acidic inputs. Recent findings that acidic precipitation is widespread and prevalent in the Precambrian Shield region of Ontario accent the importance of determining a waterbody's natural acid buffering ability. In Lake Nosbonsing, alkalinities increased through the summer periods of 1975 and 1979 increasing by approximately 2 mg/L from June to August.

The buffering capacity of Lake Nosbonsing is relatively good. Lakes with alkalinity values less than 10 mg/L are considered to be sensitive to acidic inputs. In Lake Nosbonsing, alkalinities in the 15 to 20 mg/L range are common; therefore, the lake is considered to have a low sensitivity to acidic precipitation.

3.1.4 pH:

Ministry of the Environment objectives pertinent to recreational suitability and the protection of aquatic life state that pH should be maintained within a range of 6.5 to 8.5 units. In Lake Nosbonsing, pH readings were consistently within the favourable range. The slight pH reductions observed in the bottom waters of many of the sampling stations during the summer are a commonly observed phenomenon associated with the decomposition of organic matter.

3.1.5 Colour:

Colour is a determination of the intensity of the yellow-orange hue contributed to lakes by organic matter or iron. Colour in natural surface waters is primarily associated with the presence of humic acids derived from the decomposition of plant material. Most naturally coloured waters are harmless; however, a drinking water objective of 5 Hazen units is specified for aesthetic reasons.

Colour determinations for 1975, 1978 and 1979 showed a range of colour from 15 to 33 Hazen units in the surface waters. Increases in water colour due to settled organic matter and higher iron values were observed in the near-bottom samples from Stations 3, 4 and 5 in August, 1978, when colour readings from 52 to 92 Hazen units were recorded.

3.1.6 Chloride:

Chloride is a common anion, the presence of which in high concentrations is often related to the influence of man. Chloride poses no direct health hazard but a salty taste may be noticed if concentrations exceed 250 mg/L. Urban runoff often contains high concentrations of chloride in the winter due to road salt application.

The concentrations of chloride found in Lake Nosbonsing are considered to be low. The slightly higher concentrations detected in the Astorville Basin (1.9 - 3.5 mg/L) as opposed to the 1.1 - 1.5 mg/L range for the eastern section of the lake, may either be the product of road salt application or input from shoreline development.

3.1.7 Sulphate:

Sulphate is a widely distributed ionic component in natural waters normally varying between 10 and 80 mg/L. It can also be added to a watershed through atmospheric fallout originating in the oxidation of sulphur dioxide from industrial sources.

Sulphate concentrations in Lake Nosbonsing were very low averaging 8.5 mg/L.

3.1.8 Organic Carbon:

Organic carbon is a measure of carbonaceous components and can be a factor in water colour. The concentrations of organic carbon found ranged from 4.3 to 6.0 mg/L and were considered to be moderately low.

3.1.9 Iron:

Iron is toxic to aquatic life at high levels and is objectionable in domestic water supplies because of the colour and the bitter taste it imparts. Iron can also be released from the lake bottom during the bacterial decomposition of settled organic matter under anoxic (no oxygen) conditions. During periods of lake turnover, the iron may reach surface waters and lead to unpleasant odours and shoreline discolouration.

In Lake Nosbonsing, iron build-up in the bottom waters was apparent. Concentrations above the Provincial Objectives of 0.30 mg/L were evident in June 1975. During the July sampling, Stations 2 and 3 contained near-bottom iron concentrations above 1 mg/L. A maximum concentration of 2.1 mg/L was recorded near the bottom of Station 2 in August 1975.

During the August 1978 sampling period, iron concentrations at the bottom of Station 3 were 3.7 mg/L while at Stations 4 and 5 they approached 1 mg/L.

In August 1979, a high iron concentration of 3.4 mg/L remained near the bottom of Station 2. The increases in bottom water iron concentrations were caused by the low oxygen concentrations existing near the sediments.

3.1.10 Phosphorus:

Phosphorus is considered to be the main nutrient regulating primary biological activity (algae growth). In natural surface waters, concentrations of phosphorus less than 0.010 mg/L are low and not problematic whereas concentrations higher than 0.020 mg/L may lead to problem algae growths.

In Lake Nosbonsing, total phosphorus concentrations in the surface waters ranged from a low of 0.010 mg/L to a high of 0.048 mg/L. Average surface water concentrations in the Astorville basin (Stations 1 and 2) were 0.027 mg/L while in the eastern part of the lake, an average of 0.024 mg/L was detected. In both areas, the objective of 0.020 mg/L was exceeded.

Total phosphorus concentrations in the near-bottom waters of some of the sampling stations were very high at times. At Station 2, values of 0.22 mg/L and 0.27 mg/L were detected in August 1975 and 1979. During the 1978 August sampling Station 2 appeared to be mixed from surface to bottom as no build-ups of chemical parameters were apparent in the bottom waters. However, a high build-up of phosphorus was observed at Station 3 in 1978 when a concentration of 0.080 mg/L was measured.

The general observation regarding phosphorus concentrations in the bottom waters of Lake Nosbonsing was that concentrations increased through the summer period. The cause of phosphorus build-up was attributable to a combination of factors including thermal stratification, release through decomposition of settled materials and phosphorus release from the sediments under anoxic (no oxygen) conditions.

The shallowness of Lake Nosbonsing facilitates complete water column heating by mid-summer in most of the basins. Thermal stratification is generally not persistent from spring to autumn turnover. Because of the very high phosphorus concentrations achieved in the near-bottom waters, the potential for water quality problems like algae blooms and odours is high when breakdown of temporary stratification occurs and the nutrient rich near-bottom waters are mixed with the surface.

3.1.11 Nitrogen Complexes:

In the normal course of decomposition of nitrogenous organic matter, nitrogen undergoes the following changes. Total organic nitrogen is transformed through bacterial action to ammonia which is oxidized through the unstable nitrite form to nitrate. The nitrate and ammonia forms are readily available for uptake by plants.

Concentrations of the organic total Kjeldahl nitrogen (organic nitrogen and free ammonia) form in the surface waters ranged from a moderately low value of 0.27 mg/L to a high value of 0.87 mg/L. The average concentration for the lake during the 3 year sampling period was a high value of 0.45 mg/L. However, consideration of the distribution of this parameter shows that much higher concentrations of organic nitrogen existed at Stations 1 and 2 (average 0.52 mg/L) than in the eastern portion of the lake (average 0.37 mg/L at Stations 3 - 7).

As shown in the chemical results, increases in bottom water total Kjeldahl nitrogen concentrations to very high levels (above 0.45 mg/L) coincided with increasing near-bottom phosphorus concentrations. Stations 2 and 3 showed the greatest increases. The increased Kjeldahl nitrogen in the bottom waters resulted from the breakdown of organic material (algae) settling on the bottom.

Ammonia can be directly toxic to aquatic life. It has been found that the un-ionized fraction of the total ammonia present is the toxic component and that the concentration of the un-ionized ammonia should not exceed 0.02 mg/L.

The percentage of un-ionized ammonia in aqueous ammonia solution is a function of pH and temperature. Where pH values are high (8 units or more) and warm temperatures prevail (20°C or more) total concentrations of ammonia in excess of 0.60 mg/L may be problematic.

Because ammonia concentrations as high as 0.60 mg/L are only rarely found even under anoxic (no oxygen) conditions where fish will not be found anyway, the low oxygen situation will usually be more biologically significant than high ammonia values.

Surface water ammonia concentrations fluctuated between values of 0.005 mg/L and 0.18 mg/L and were not of concern. Bottom water ammonia concentrations ranged from 0.02 mg/L to a very high 0.738 mg/L at the bottom of Station 2 on August 29, 1979. In August of 1975 a very high ammonia concentration of 0.60 was also recorded at Station 2.

The toxic potential of the ammonia concentrations at the bottom of Station 2 was evaluated according to the method described in the Ministry of the Environment publication "Water Management". An ammonia concentration of 0.738 mg/L at 15°C and pH 7.5 (similar to conditions at Station 2) gives an un-ionized concentration of 0.006 mg/L. This is less than 1/3 of the un-ionized ammonia objective of 0.02 mg/L.

Although bottom water ammonia concentrations are high, they are reflective of a high order of biological productivity in a reducing (low oxygen) environment and are not a direct source of concern under the conditions which exist at times in Lake Nosbonsing.

Concentrations of the unstable intermediate nitrite were very low and never exceeded 0.008 mg/L.

The nitrate form of nitrogen followed the expected concentration and distribution pattern for biologically productive lakes. Surface water concentrations were very low at all times likely due to rapid uptake by the numerous algae and other aquatic plants. Bottom water concentrations were also low at all stations. At the shallower sampling locations where thermal stratification was not persistent, nitrate uptake by plants was likely a factor in maintaining low near-bottom concentrations. At the deeper, stratified sampling locations the reducing environment favoured the presence of the ammonia form of nitrogen.

3.1.12 Inorganic Carbon:

Inorganic carbon is a measure of the carbon in the bicarbonate and other forms that are readily available to support biological productivity. Concentrations in surface and near-bottom waters of Lake Nosbonsing remained in the low to moderate range of 2.0 to 9.8 mg/L.

The higher concentrations of inorganic carbon were detected near the bottom of the thermally stratified stations due to the contribution of respired carbon dioxide from decomposition of sedimented material.

3.1.13 Surface Water Chemistry:

Results of euphotic zone (surface) water chemistry analyses for May 21, 1975, May 24, 1979, and May 19, 1980 are shown in Appendix D. Sampling station locations are shown in Figure 2.

Surface water chemistry data characterized Lake Nosbonsing as a very soft (hardness 22 mg/L), yellow-tinged (colour 15 - 32 Hazen units) neutral body of water (pH 6.9 - 7.4) with a moderate load of dissolved substances (conductivity 54-66 umhos/cm). The buffering capacity to acidic inputs was good (alkalinity 14 - 18 mg/L).

Concentrations of the major nutrient elements, phosphorus (0.016 - 0.044 mg/L) and nitrogen (0.29 - 0.89 mg/L), spanned the moderate to high range. Inorganic carbon levels (3.0 - 4.2 mg/L) were low. Organic carbon concentrations (4.4. - 5.6 mg/L) were moderately low.

The major cations, calcium (5.8 mg/L) and magnesium (1.65 mg/L) were present in concentrations normally occurring in North Bay area lakes.

Chloride (1.4 - 3.9 mg/L) and sulphate (9.0 mg/L) concentrations were low.

3.2 METALS:

Results of metal analyses for the six sampling locations, on June 20, 1979 are shown below along with Ontario's objectives for (MOE 1978).

PARAMETER	STATION						MOE OBJECTIVE
	1	2	3	4	5	6	
Copper	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.005
Nickel	All concentrations less than 0.02						0.025
Lead	All concentrations less than 0.04						0.005
Zinc	All concentrations less than 0.01						0.030
Cadmium	All concentrations less than 0.005						0.0002
Chromium	<0.02	0.04	0.06	0.05	0.04	0.05	0.100
Aluminum	0.03	0.03	<0.02	<0.02	0.45	<0.02	No Objective.

*concentrations in mg/L.

Water which meets the water quality objectives for aquatic life and recreation will be suitable for most other uses such as drinking water and agriculture. Ontario's metal objectives are based on the total concentration in an unfiltered sample. It is recognized that metals may not be toxic in particulate or bound form and that it is possible for the total concentrations to exceed the objectives without damaging any aquatic life.

The concentrations of metals in Lake Nosbonsing were low and generally below the detection limits of the analytical methods used. In the cases of copper, lead and cadmium, the objectives are set lower than the detection limits (reported above).

3.3 SPRING PHOSPHORUS:

It has been found (Dillon, 1974) that the trophic status (degree of nutrient enrichment) of lakes can be related to the amount of phosphorus present at spring turnover when the water is completely mixed.

General categories or levels of water quality based on the quantity of total phosphorus present in the spring have been identified.

NOTE: Concentrations of phosphorus are reported as mg/m³. This is equivalent to µg/L or parts per billion.

LEVEL 1 (Excellent)

Springtime phosphorus concentrations between 0 and 9.9 mg/m³. Such lakes are primarily suited for body contact recreation because of extremely clear water and low order of biological productivity. In deep lakes, dissolved oxygen concentrations in hypolimnetic (bottom) waters will remain favourable for the support of cold water fish species like lake trout.

LEVEL 2 (Good)

Springtime phosphorus concentrations between 10 and 18.5 mg/m³. Lakes in this category are suitable for water-based recreation but the preservation of cold water fisheries is not guaranteed. Level 2 lakes are less clear with moderate primary biological activity.

LEVEL 3 (Fair)

Springtime phosphorus concentrations between 18.5 and 29.9 mg/m³. Level 3 lakes are characterized by reduced suitability for body contact aquatic recreation because of high concentrations of suspended algae and associated nuisances like odours and turbid water. Oxygen depletion in deep basins will be common and there is danger of winterkill of fish in shallow lakes.

LEVEL 4 (Poor)

Springtime phosphorus concentrations above 30 mg/m³. Such lakes are suitable only for warm water fisheries and there is considerable danger of winterkill of fish. Other recreational uses like swimming, boating and water skiing are extremely unpleasant at times.

The springtime phosphorus concentrations of Lake Nosbonsing were determined on three occasions. In 1975 total phosphorus concentrations ranged from 15 to 26 mg/m³ (Figure 5). There appeared to be a division of trophic conditions on the basis of the concentrations found. The basin west of Shields Point averaged 26 mg/m³ phosphorus indicating a Level 3 classification. The rest of the lake averaged 17.8 mg/m³ phosphorus which is within the Level 2 category.

In 1979, a total phosphorus range of 16 to 23 mg/m³ was detected (Figure 5). Phosphorus distributions similar to those observed in 1975 were evident. Springtime phosphorus concentrations in the western end of the lake averaged 23 mg/m³ consistent with a Level 3 classification. The section of the lake east of Shields Point was classified as Level 2 with an average phosphorus concentration of 18.3 mg/m³.

During the spring of 1980, concentrations of phosphorus ranged from 19 to 44 mg/m³ and were generally higher than in previous years. In the western end of the lake, spring phosphorus concentrations averaged 39 mg/m³ while the eastern end of the lake had an average phosphorus concentration of 20 mg/m³ (Figure 5).



Ministry of the Environment, Northeastern Region



BONFIELD

ASTORVILLE

SPRINGTIME PHOSPHORUS

CONCENTRATIONS (mg/m³)

LAKE NOSBONSING

- 1975
- 1979
- ◇ 1980

SCALE : 1 : 50,000

Figure 5

Monitoring of springtime phosphorus concentrations is summarized below:

SPRINGTIME PHOSPHORUS LEVELS (mg/m³)

<u>YEAR</u>	<u>WESTERN END</u>	<u>EASTERN END</u>
1975	26.0	17.8
1979	23.0	18.3
1980	39.0	20.0

The western basin near Astorville contained spring phosphorus concentrations spanning the Level 3 and Level 4 classifications. The eastern part of Lake Nosbonsing was classified in the high Level 2 and early Level 3 category.

The 1980 phosphorus readings for the Astorville basin were much higher than expected. Examination of water chemistry information showed the presence of high concentrations of Kjeldahl nitrogen (0.51 - 0.56 mg/L) in the western basin during the spring phosphorus sampling period. Since the Kjeldahl nitrogen test is an indication of the nitrogen present in the organic form (amino-acids, proteins), it is suspected that the phosphorus results were elevated by the presence of high concentrations of suspended algae.

The Level 4 classification given to the Astorville basin following the 1980 sampling was not considered to be representative of the actual conditions.

3.4 TROPHIC STATUS:

The deterioration of water quality in recreational lakes is generally associated with nutrient enrichment resulting in increased biological activity. Usually the biological activity is seen as a greater density of phytoplankton (suspended algae). The greater the degree of enrichment the higher the concentration of phytoplankton with the result that water clarity is diminished.

Water clarity is measured with a Secchi disc while the concentration of phytoplankton can be approximated by the analytical determination of chlorophyll a, a green photosynthetic pigment in the microscopic plants.

Historical data and a lake classification system based on the average summertime chlorophyll concentrations have been combined to allow mean annual Secchi disc readings and chlorophyll a concentrations to be grouped into ranges representing 4 degrees of water quality. This classification system corresponds to that used for spring phosphorus.

<u>LEVEL 1</u>	Chlorophyll <u>a</u> concentrations 0-2 $\mu\text{g/L}$, excellent water quality.
<u>LEVEL 2</u>	Chlorophyll <u>a</u> concentrations 2-5 $\mu\text{g/L}$, good water quality.
<u>LEVEL 3</u>	Chlorophyll <u>a</u> concentrations 5-10 $\mu\text{g/L}$, fair water quality.
<u>LEVEL 4</u>	Chlorophyll <u>a</u> concentrations above 10 $\mu\text{g/L}$, poor water quality.

Analytical chlorophyll a data and average Secchi disc readings are plotted on a graph displaying the ranges of Secchi disc visibility and chlorophyll a associated with specific levels of water quality.

Results for chlorophyll a ($\mu\text{g/L}$) CHL a and Secchi disc visibility (m) S.D. are shown below.

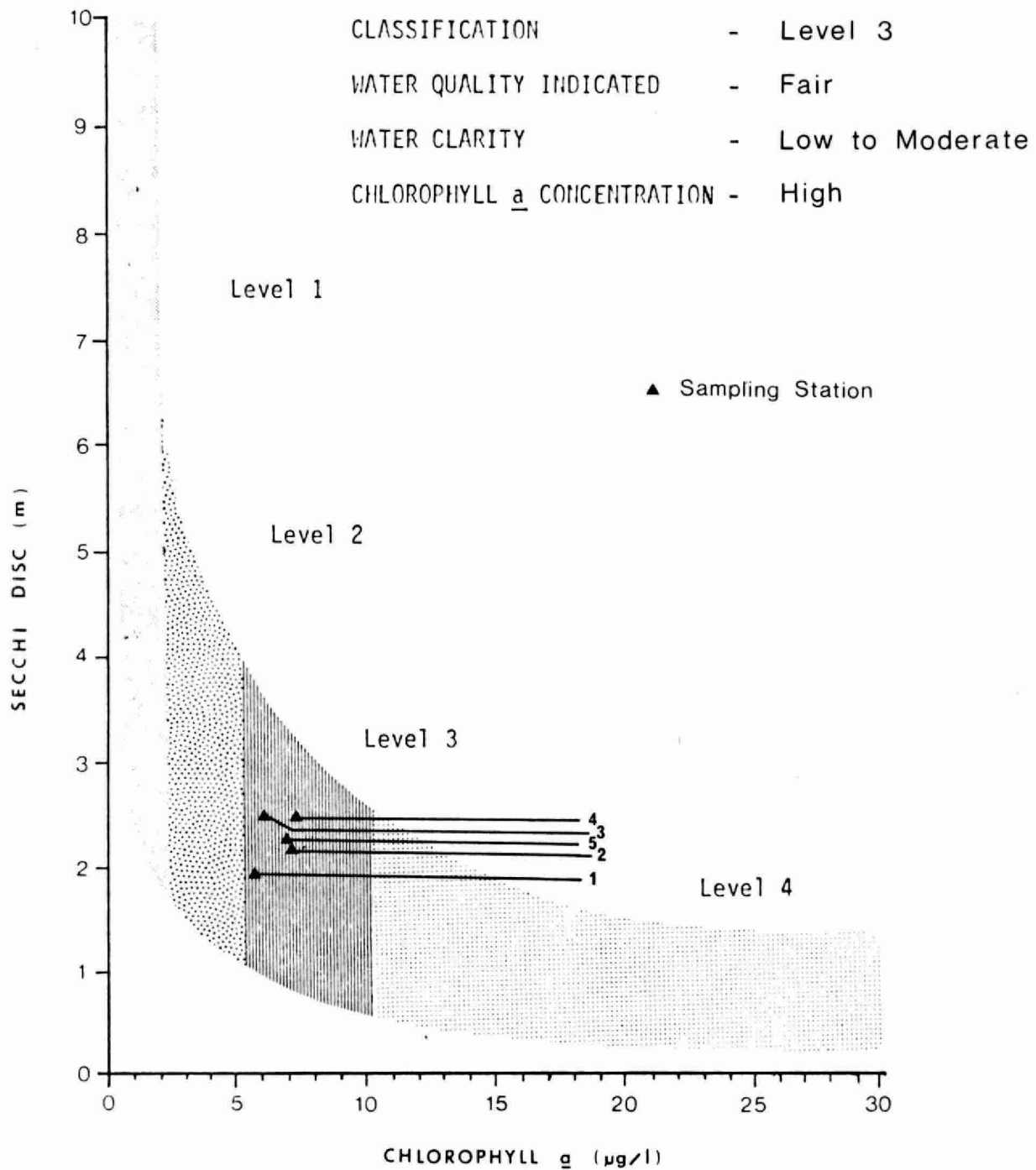
CHLOROPHYLL a - SECCHI DISC MONITORING RESULTS
1975 - 1979

DATE	SAMPLING STATION									
	CHL <u>a</u> ¹	S.D.	CHL <u>a</u> ²	S.D.	CHL <u>a</u> ³	S.D.	CHL <u>a</u> ⁴	S.D.	CHL <u>a</u> ⁵	S.D.
<u>1975</u>										
May 26	11	2.1	11	3.0	6.0	3.0	5.8	3.0	3.0	2.3
June 2	-	2.2	-	2.6	-	3.8	-	3.4	-	3.2
6	3.5	1.8	4.4	2.6	2.1	2.7	2.2	2.7	1.9	2.1
17	1.0	1.6	1.1	2.1	2.8	2.4	3.6	2.5	2.9	1.7
25	3.9	2.1	2.9	2.4	1.6	2.7	1.6	3.0	5.0	2.1
July 2	-	2.5	-	3.0	-	4.2	-	4.0	-	3.2
Aug. 4	2.8	1.9	3.4	2.0	5.5	2.4	5.7	2.6	5.2	2.1
7	11	1.7	13	1.5	18	1.3	18	1.1	12	1.6
19	-	1.5	-	1.0	-	0.75	-	0.75	-	0.75
<u>1978</u>										
Aug. 22	5.1	2.0	5.4	2.0	2.1	4.0	2.6	3.0	2.6	4.0
<u>1979</u>										
June 20	8.4	2.0	6.7	3.0	6.5	2.0	6.4	2.5	4.8	2.5
Aug. 29	-	-	15.6	1.5	--	--	18	1.5	24.6	1.0

Figure 6

LAKE NOSBONSING

1975-1979



LAKE CLASSIFICATION BASED ON CHLOROPHYLL a
 SECCHI DISC RELATIONSHIP

KEY: Secchi Disc Visibility(m)

Chlorophyll a Concentration($\mu\text{g/l}$)

- 5 + excellent
- 2.5 - 5 moderate
- 1 - 2.5 low
- 0 - 1 poor

- 0 - 2 low
- 2 - 5 moderate
- 5 - 10 high
- 10 + excessive

Secchi disc visibilities at Station 1, near Astorville, were in the low range on each day sampled. At the remaining stations, water clarity determinations spanned the low and moderate ranges. At Stations 3, 4 and 5, poor visibilities of 0.75m were recorded on August 19, 1975.

Chlorophyll a determinations were highly variable. Concentrations at each station varied from low to excessive levels. Chlorophyll a concentrations greater than 10 µg/L were indicative of algae blooms.

Mean Secchi disc and chlorophyll a values plotted on the accompanying chart (Figure 6) show that Lake Nosbonsing is classified in the Level 3 category of water quality. A fair order of water quality with low to moderate Secchi disc visibilities and high chlorophyll a concentrations is indicated.

3.5 DISSOLVED OXYGEN AND TEMPERATURE:

Oxygen and temperature profiles for Stations 2, 3, 5 and 6 were developed for July and August 1975. Profiles were also developed for June and August, 1979, at the same locations (Appendix E).

Lake Nosbonsing is relatively shallow. The deepest basin (Station 3) is approximately 14 metres deep.

On July 2, 1975, thermal partitioning of the warm surface water (25°C) and the cooler bottom water (9 - 16°C) occurred at a depth of approximately 7 metres.

At this early stage of stratification, dissolved oxygen concentrations in the bottom water zone decreased with depth. Reductions of the dissolved oxygen levels below MOE warm water biota objectives were noted in the hypolimnetic (bottom) waters of Stations 2, 3 and 5. The high sediment oxygen demand was emphasized by the extremely low oxygen readings in the hypolimnion of each station.

On August 19, 1975, thermal stratification was evident at Stations 2 and 3. The zone of temperature change (thermocline) occurred at a depth of 7 to 8 metres. Severe oxygen depletion was recorded in the hypolimnetic waters of the two western basins.

The water column at Stations 5 and 6 was uniformly heated from surface to bottom. This facilitated aeration by surface mixing. Dissolved oxygen levels were acceptable throughout the water column.

The development of dissolved oxygen-temperature profiles for 1979 revealed vertical distributions similar to those found in 1975. On June 20, the thermocline (zone of temperature decline) occurred at a depth of approximately 7 metres. At Stations 2 and 3, dissolved oxygen concentrations were below the M.O.E. objectives for the bottom 5 metres. At the shallower Stations 5 and 6, there were lesser reductions of dissolved oxygen near the bottom.

On August 28, thermal partitioning was still apparent at Stations 2 and 3. As in June, dissolved oxygen concentrations below the thermocline were very low at these stations.

The oxygen-temperature distributions at Stations 5 and 6 were slightly different than those observed in 1975 when homothermal (uniform temperature surface to bottom) conditions prevailed. The 2°C bottom water temperature reduction from the surface waters resulted in a weak thermal partitioning at a depth of approximately 8 metres. Below this depth, dissolved oxygen concentrations declined to values well below the M.O.E. objectives.

During both sampling years, 1975 and 1979, distributions of dissolved oxygen in the deeper stratified basins (Stations 2 and 3) displayed the clinograde shapes associated with nutrient enriched (eutrophic) conditions. Oxygen concentrations below the warm surface layers of these basins were very low approaching values of zero in some instances.

The oxygen-temperature profiles reveal that Lake Nosbonsing has the low oxygen characteristics associated with the poor water quality of eutrophic lakes. However, this classification on the basis of the dissolved oxygen regime only, may be premature.

As Lake Nosbonsing is shallow, the establishment of a thermocline at a depth of 6 - 8m leaves a relatively small volume of hypolimnetic water to meet the oxygen demands of high quantities of sedimented algae and those of the organic sediments.

The turbidity of Lake Nosbonsing is also a factor in the poor dissolved oxygen regime. In clear lakes, surface heating during the summer period would normally result in the establishment of a thermocline to a depth greater than the 6 - 8m found in Lake Nosbonsing. In fact, homothermal conditions generally exist by mid-summer, facilitating complete water column mixing. Because of the low order of light penetration in Lake Nosbonsing, the thermocline remains at a shallow depth and a persistent hypolimnetic zone with very low dissolved oxygen concentrations remains throughout the summer period.

The dissolved oxygen concentrations found in Lake Nosbonsing were sufficiently low to exert stress on organisms inhabiting the lake bottom.

3.6 MICROBIOLOGICAL WATER QUALITY:

In 1975, three five-day microbiological surveys of Lake Nosbonsing revealed that the water quality was generally good and within the limits of the Ministry of the Environment's Objectives for swimming and bathing use of water (total coliform 1000/100 mL; fecal coliform 100/100 mL).

During the May to June survey, the geometric mean densities for the greater part of the lake were 26 total coliforms (TC), 2 fecal coliforms (FC) and 2 fecal streptococci (FS) per 100 mL (Group A, Figure 7). The areas on either side of the McConnell Point Peninsula (Groups B and C) were found to have slightly elevated fecal streptococcus densities of 5 and 12 per 100 mL respectively. These bacteria were probably of non-fecal origin since the corresponding FC numbers did not show an increase. Bacterial densities higher than the lake average were also detected at a few scattered locations and near three stream inflows.

The locations of increased bacterial densities are shown below:

STATION	GEOMETRIC MEAN DENSITY/100 mL		
	TC	FC	FS
1	26	13	5
3	26	5	2
12	26	10	2
32	26	11	2
40	26	12	2
5	306	18	19
13	26	44	24
17	26	27	4

The FC:FS ratio at Stations 12, 32, 40 and the inflow Station 17 exceeded 4, thus the probable source of bacterial contamination was of human origin.



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Ontario

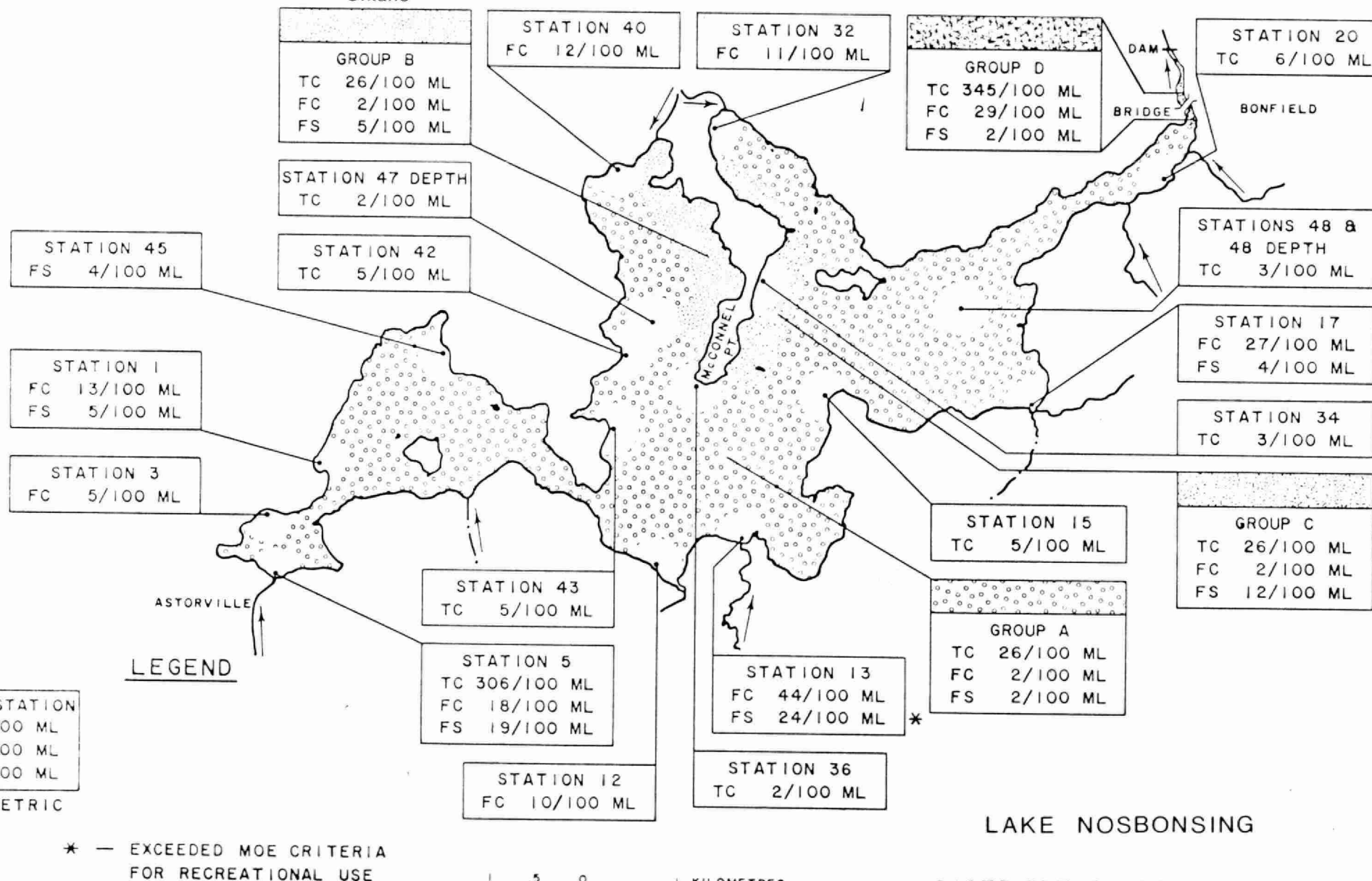


Figure 7

Another zone of high bacterial densities was the channel leading to the outflow at Bonfield (Group D). Densities rose to 345 TC, 29 FC and 2 FS/100 mL. The FC:FS ratio of greater than 4 suggested a human source of contamination.

The pathogenic bacterium Pseudomonas aeruginosa was not generally isolated from the main body of the lake. Low levels, 2 per 100 mL, were occasionally detected near Bonfield at Stations 22, 23 and 24.

During the July survey the southeastern area of Lake Nosbonsing had geometric mean densities of 12 TC, 3 FC and 3 FS per 100 mL. (Group A, Figure 8). The lake was homogenous for fecal streptococci with a value of 3 FS per 100 mL. An exception was the southern inflow Station 13 where a fecal streptococcus density of 123 FS per 100 mL was detected. The relative levels of fecal coliforms and fecal streptococci at this station indicated the fecal contamination to be of animal origin.

The western part of the lake near Astorville had geometric mean densities of 56 TC, 3 FC and 3 FS per 100 mL (Group B, Figure 8).

The waters surrounding the northern peninsula and those off the eastern shore of Lake Nosbonsing (Groups C and D) had identical concentrations of 12 TC and 1 FC per 100 mL. The



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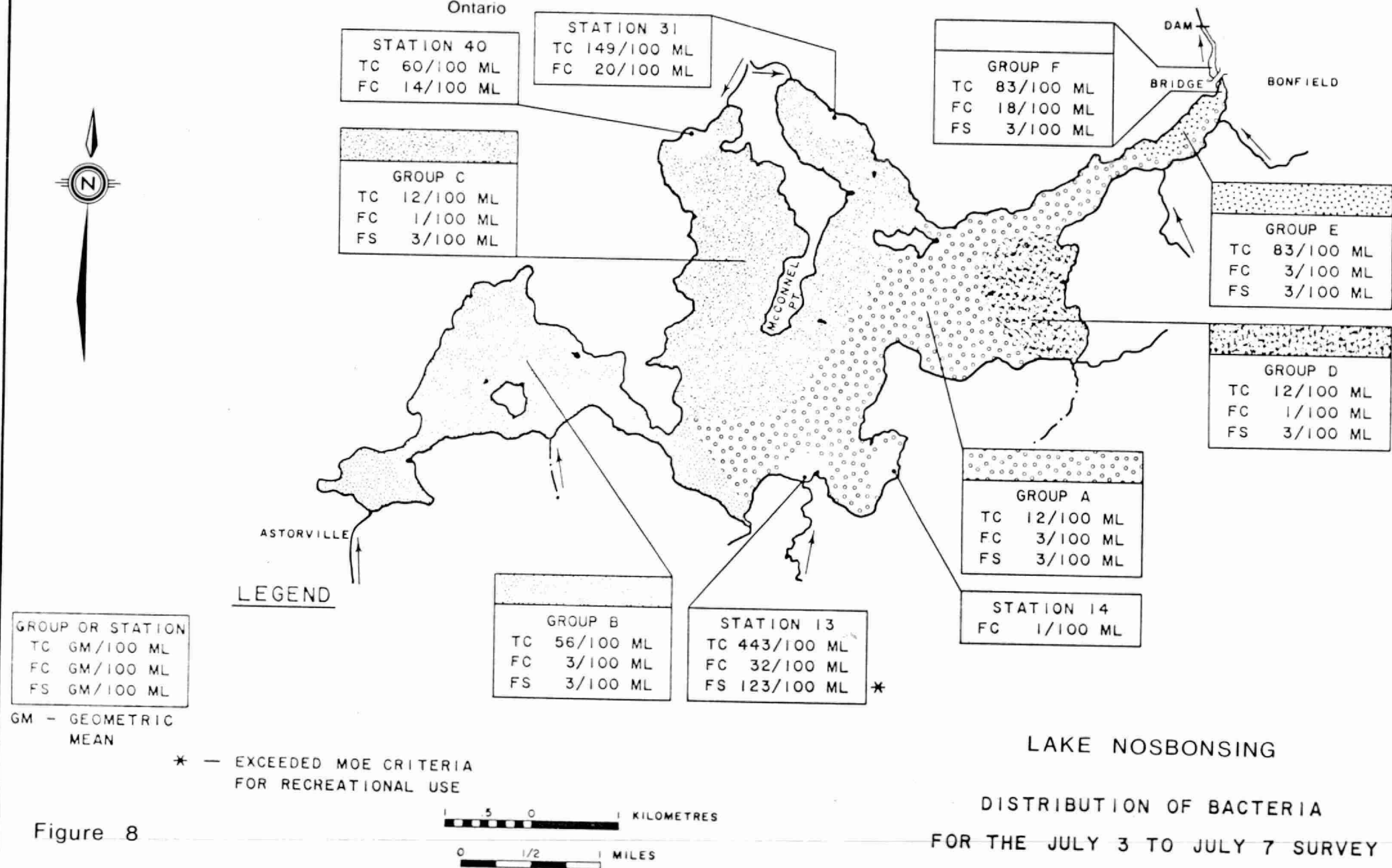


Figure 8

very low levels of fecal coliforms indicated very little bacterial contamination in this area. At a few shoreline sampling locations, Stations 40, 31 and near Bonfield (Group F), bacterial densities showed a marked increase over nearby waters. The higher levels of bacteria noted were likely the result of increased human activities in those areas.

Pseudomonas aeruginosa was not generally found in the lake; however, some areas, including sampling Stations 7, 8, 11, 15, 19, 25, 28, 31, 39 and 40, yielded P. aeruginosa densities ranging from 1 to 3 per 100 mL.

In August, the bacterial densities were low over most of the lake, averaging 11 TC, 3 FC and 2 FS per 100 mL (Group A, Figure 9). The lake was generally homogenous for fecal streptococci with densities of 2 FS per 100 mL, but exceptions were observed in the western bay (Group B) and at inflow Station 13 where values of 5 and 13 FS per 100 mL respectively were detected. The increased FS densities at these locations were likely of natural origin since corresponding FC densities did not increase.

The area surrounding the McConnell Point peninsula (Group C) revealed very low densities of 2 TC, 2 FC and 2 FS per 100 mL. Further south (Group D) and in the northeastern channel (Group E), the TC densities rose to 78 and 73 per 100 mL respectively. The fecal coliform densities were identical to those found in the nearby waters.



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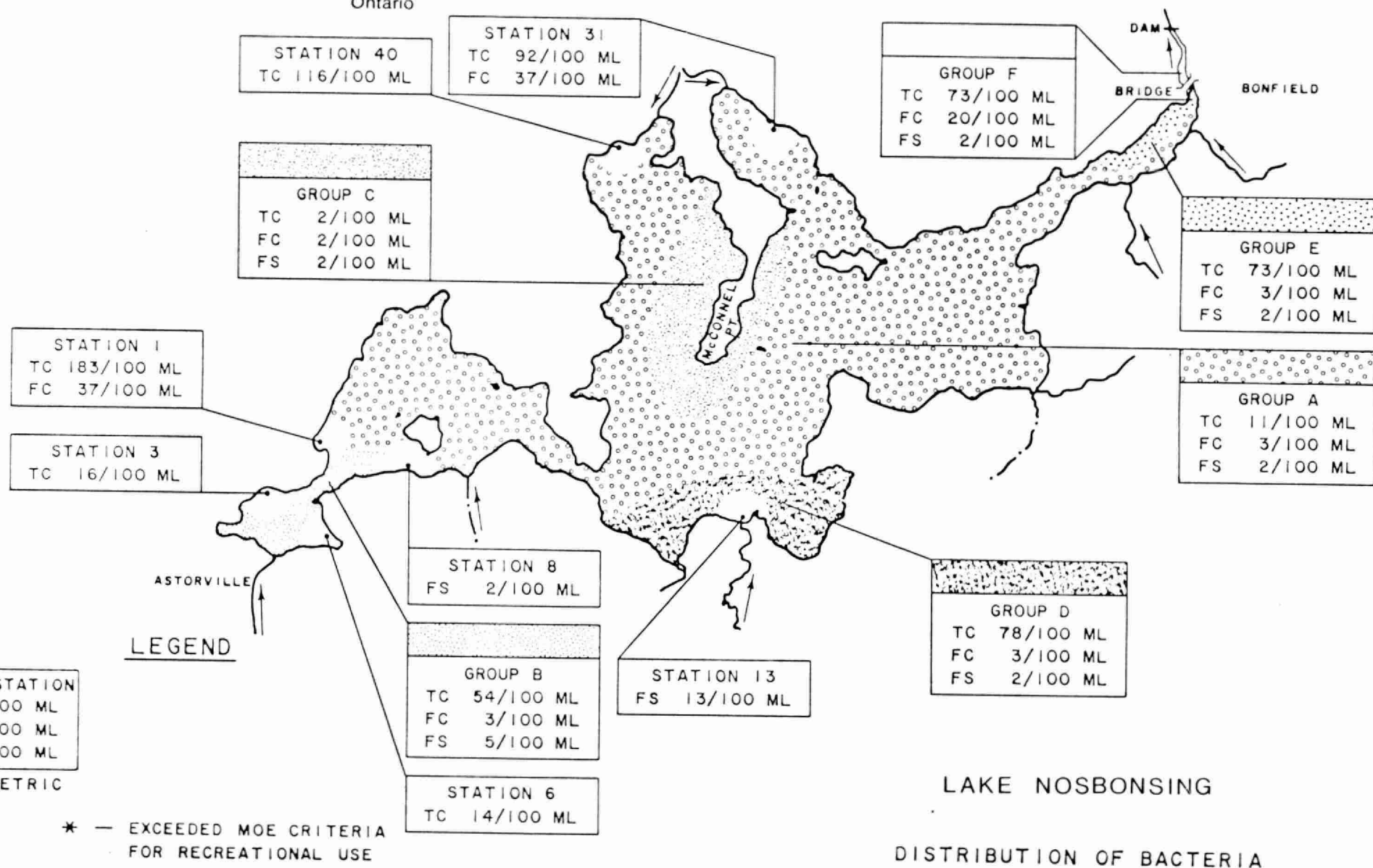


Figure 9

Zones of increased bacterial density were found at Stations 1, 31 and near Bonfield (Group F). Densities ranged from 73 to 183 TC per 100 mL and 20 to 37 FC per 100 mL. The increases in fecal coliform levels were indicative of possible human contamination since the FC:FS ratio was greater than 4.

At certain Stations: 1, 4, 9, 15, 25, 36, 38, 40 and 42, mean densities of Pseudomonas aeruginosa between 1 and 2 per 100 mL were detected.

Overall, the three microbiological surveys revealed that the shores of the McConnell Point peninsula and the eastern shores of Lake Nosbonsing had consistently low levels of bacteria. In the small basin near Astorville, bacterial densities rose throughout the summer; whereas, in the main part of the lake bacterial densities declined through the summer. A small area of the lake at Bonfield showed consistently high bacterial densities during all three surveys. A source of pollution originating in human waste was strongly indicated in this region.

The densities of fecal coliforms at the inflows were affected by rainfall during the May-June survey (Figure 7). A rainfall guage placed on the western shore of Lake Nosbonsing during the period of the survey, recorded 22.3mm of rain. It appeared that many bacteria were washed from the surrounding soil into the streams elevating fecal coliform concentrations.

In the main body of the lake, including the area surrounding the peninsula, fecal coliform densities were not affected by the rainfall, indicating that the rainfall effect was not of great influence.

The effect of existing shoreline development on the lake was demonstrated by the microbiological surveys. The small basin at Astorville and particularly the area near Bonfield, showed evidence of increased bacterial densities resulting from human activities. In addition, elevated densities of bacteria of human origin were detected near a marina (Station 31) and a trailer camp (Station 40).

Another source of fecal bacteria was rainfall runoff which washed in fecal bacteria of animal origin. The mouths of inflow streams designated as sampling Stations 5, 13 and 17 were the best examples of this rainfall effect which becomes more pronounced as lakes are developed.

While reference to increased or elevated bacterial densities was expressed overall, the survey results for Lake Nosbonsing were good, indicating low bacterial density. At no time were total coliform (TC) densities in excess of the recreational use objective of 1000 per 100 mL and fecal coliform (FC) densities never approached 100 per 100 mL. On the basis of the survey results, Lake Nosbonsing was suitable for body contact recreation (swimming) at all times.

While the population densities of bacteria were within the range normally found in good quality surface waters, the presence of total coliform, fecal coliform and fecal streptococcus groups renders untreated water unsuitable for human consumption. Homeowners who use water from the lake are advised to use appropriate treatment methods (chlorination or boiling) to ensure that water used for drinking is bacteriologically safe.

3.7 INFLOWING STREAM CHEMISTRY:

Results of chemical analyses for inflowing streams are summarized in Appendix F. The significance of the chemical composition of the inflowing streams is discussed relative to the chemistry of the receiving waterbody.

All inflows sampled entered the lake along its southern shore. The streams NL-1 to NL-4 emptied to the western end of Lake Nosbonsing.

3.7.1 Major Inflows (NL-2,5,6,8 and 9):

Stream NL-2 originated in a swampy area and maintained flow throughout the sampling period. The water chemistry monitoring record from April through September revealed a composition pattern greatly influenced by melting snow and runoff. During the peak runoff period (April), conductivity values (33-65 umhos/cm) were lowest from the input of dilute snow melt while pH (6-6.6) and alkalinity (9-12 mg/L) were slightly depressed.

Stream NL-2 functioned as an importer of sulphates (10.7 mg/L), iron (1.7 mg/L) and nutrients to the western basin of Lake Nosbonsing. Total phosphorus concentrations ranged from 0.028 to 0.108 mg/L and averaged 0.058 mg/L. Total nitrogen concentrations were also high averaging 0.9 mg/L.

The highest concentrations of phosphorus and available nitrogen (nitrate and ammonia) were present during the April sampling period.

Average hardness, calcium, magnesium, chloride and conductivity values for NL-2 were similar to those found in the western end of Lake Nosbonsing.

Station NL-5, is the first major inflow to the large eastern portion of Lake Nosbonsing. It originates in Mink Lake and functions in a diluting capacity. Average conductivity determinations (43 umhos/cm) are lower than the 55 umhos/cm readings obtained for the lake.

Average concentrations of all chemical parameters determined were equal to or lower than those found in the lake except for phosphorus and nitrogen. Phosphorus concentrations averaged a moderately high 0.025 mg/L, and nitrogen averaged 0.65 mg/L. During the peak runoff period in April, approximately 50% of the nitrogen was present in the available ammonia and nitrate forms.

The Nosbonsing River, NL-6, empties to the lake near the middle of its southern shore and is the lake's largest inflow. Its influence on the water chemistry of Lake Nosbonsing is evident from the examination of the river's water chemistry.

Average conductivity over the six month sampling period was similar to the 55 umhos/cm value for the lake. In addition, hardness, alkalinity, calcium and magnesium exhibited average concentrations reflective of those present in the eastern part of the lake. Sulphate concentrations averaging 10.1 mg/L were slightly higher than the spring lake average of 7.5 mg/L; however, the input of chlorides was substantially lower, since average inflow concentrations of 0.56 mg/L were approximately one third those present in the lake. The input of the nutrient phosphorus appeared to be significant with a high average concentration of 0.083 mg/L in the Nosbonsing River. Concentrations on individual sampling dates ranged from a moderate 0.018 mg/L to a very high 0.375 mg/L. The highest concentrations of total phosphorus were measured during peak spring runoff and were associated with a heavy load of suspended solids (144 - 168 mg/L). The low concentrations of dissolved reactive phosphorus present (0.001 - 0.002 mg/L) when high total phosphorus concentrations were determined suggest that much of the phosphorus was bound to particulate matter and was not easily available to aquatic plants.

Total nitrogen concentrations were moderate averaging 0.52 mg/L. As with the other inflows, available nitrogen (ammonia and nitrate) constituted a high proportion of the total nitrogen load during peak runoff.

Streams NL-8 and NL-9, the eastern-most major inflows enter Lake Nosbonsing in close proximity. As major inflows, an April through September chemical record is available. The average composition of both inflows exhibited similarity. The dissolved solids load was lower than that of the receiving waterbody with conductivity values averaging 41-44 umhos/cm as opposed to the 55 umhos/cm detected in the lake. Incoming hardness, alkalinity, calcium, magnesium, chloride and pH determinations were lower in both streams. Sulphate concentrations (11 mg/L) were higher in NL-9.

Both inflows supplied moderate concentrations of the nutrient phosphorus to the lake with NL-8 averaging 0.024 mg/L and NL-9 averaging 0.033 mg/L. Nitrogen inputs were also moderate. Like all other inflowing streams, NL-8, and NL-9 were importers of iron to the lake.

3.7.2 Minor Inflows (NL-1,3,4 and 7):

Inflow NL-1, a runoff channel, was sampled during April. The influence of urban runoff from Astorville was evident in the water chemistry of this inflow. Conductivity

determinations, which reflect the concentrations of dissolved substances, averaged 112 umhos/cm, approximately twice those of the receiving lake basin. Chlorides, from the application of de-icing salt, averaged 15 mg/L, roughly four times the concentrations found in the lake. Calcium and magnesium, likely originating in winter sanding operations, were slightly elevated over lake values and contributed to higher hardness of this inflow.

The levels of sulphate (12.8 mg/L) and iron (0.83 mg/L) were elevated above lake values. The concentrations of nutrients in NL-1 were also high. Total phosphorus concentrations ranged from 0.026 to 0.108 mg/L and averaged 0.064 mg/L with an average of 0.012 mg/L in a reactive form. Total nitrogen concentrations averaged a high 1.2 mg/L. Roughly half of this was in the ammonia and nitrate forms which are readily available to promote plant growth. Inflow NL-1 also functioned in an importing capacity with respect to sulphate (12.8 mg/L) and iron (0.83) mg/L.

NL-3 was considered a minor inflow but had significant impact since it received drainage from an adjacent barnyard. Samples were taken three times in April and during the first week in May while flow conditions were adequate for sampling.

Although NL-3 was responsible for the addition of some sulphate (11 mg/L), iron (2.1 mg/L) and nutrients (phosphorus 0.096 mg/L, nitrogen 0.86 mg/L), it contained fewer dissolved substances than did the receiving waterbody. Conductivity values for NL-3 averaged 47 umhos/cm while the Astorville basin of the lake had spring conductivity readings of 60 umhos/cm.

Hardness, alkalinity, pH, chlorides and calcium in NL-3 were lower in value than levels found in Lake Nosbonsing.

Inflow NL-4 was a runoff channel with sufficient flow to allow sampling only on April 9.

The dilute nature of this inflow was underscored by a low conductivity of 33 umhos/cm and low concentrations of all parameters investigated except phosphorus (0.060 mg/L) and nitrogen (0.68 mg/L).

NL-7, an intermittent stream flowing to South Bay was sampled twice in April. Hardness, alkalinity and sulphate values were similar to those found in Lake Nosbonsing. Calcium, magnesium and pH values were lower than those in the lake while conductivity, iron and chloride concentrations were higher. Both total phosphorus (0.072 mg/L) and total nitrogen concentrations (1.2 mg/L) were high.

3.7.3 Summary:

The overall impact of the inflows to the southern shore of Lake Nosbonsing is difficult to assess although some of the characteristics of the inflows are unique.

Each inflow was characterized by a high colour component. The yellow-orange hue associated with the presence of humic substances was present in varying intensities. In addition, high concentrations of iron likely originating in the watershed, added to the colour of the inflows.

The effects of road salt use were apparent in flows NL-1, 2 and 7 which exhibited spring pulses of chloride. The influence of runoff from the road system near Astorville is seen in the chloride concentrations of the western end of Lake Nosbonsing. Chloride concentrations (3-4 mg/L) although considered to be relatively low, were approximately twice as high near Astorville as in the eastern end of the lake (1.5 mg/L).

The initial purpose of inflow monitoring was to investigate nutrient transport via inflowing streams as a possible explanation for the state of enrichment observed in Lake Nosbonsing. The nutrient of greatest concern was phosphorus.

Ministry of the Environment Water Management Objectives for rivers and streams indicate that total phosphorus concentrations should remain below 0.030 mg/L to avoid nuisance growths of plants and algae.

For the streams emptying to the Astorville basin, the 0.030 mg/L phosphorus objective was exceeded 3 of 4 times at NL-1, 12 of 13 times at NL-2, all 4 times at NL-3, the barnyard drainage, and during the only time NL-4 was sampled.

For streams flowing to the eastern part of Lake Nosbonsing, the phosphorus objective was rarely exceeded at stations NL-5, NL-8 and NL-9, but was exceeded both times that NL-9 was sampled and was exceeded 9 of the 13 times samples were analyzed from the Nosbonsing River (NL-6).

3.7.4 Watershed Nutrient Model:

A watershed nutrient modeling approach using a computer model (after Dillon 1974) was used to investigate the influence of the inflowing streams on the measured phosphorus concentrations of Lake Nosbonsing.

In simple terms, the modeling technique estimates the quantity of phosphorus entering the lake via the inflowing streams during the year and predicts the concentration of phosphorus that would be measured following lake mixing in the spring. The springtime phosphorus value is used to determine water quality.

Because of the physical separation of Lake Nosbonsing by the narrows at Shields Point and water chemistry differences between the western and eastern basins, each basin of the lake was modeled separately.

The watersheds discharging into each basin were then subdivided according to the drainage areas of the component streams sampled. The phosphorus supplied from the sub-watersheds was determined by estimating the yearly discharge of water (runoff $\times$ watershed area) and multiplying the discharge by the phosphorus concentration of the stream.

Since approximately 55 percent of the annual discharge for streams and rivers in the vicinity of Lake Nosbonsing occurs during the spring freshet (March to May) the average phosphorus concentrations measured during the March and April sampling period were used to calculate the spring runoff phosphorus supply. The remaining 45 percent of the annual phosphorus supply was estimated from the average stream phosphorus concentrations measured from May to September.

The annual phosphorus supply was converted to a watershed export factor ($\text{mg}/\text{m}^2/\text{yr.}$) for use in the Dillon nutrient modeling approach. A detailed description of the Dillon's Model is available from the Ministry of the Environment upon request.

The western (Astorville) basin was influenced by five watershed areas containing inflows NL-1 through NL-4 and land along the basin's north and south shores. The total watershed area was 12741910 m^2 while the phosphorus supply was calculated as 335.2 kg/year . The watershed export factor was $26.3 \text{ mg/m}^2/\text{year}$.

Phosphorus was supplied to the eastern basin by six watershed areas including inflows NL-5 through NL-9, the outflow from the western basin along with the land area along the northeastern shoreline of the lake.

The total watershed area of the eastern basin was $108,128,988 \text{ m}^2$ while the phosphorus supply was calculated as 3645.5 kg/year . Of this, 2894.0 kg/year were contributed by the Nosbonsing River (NL-6). The watershed export factor for the eastern basin was $33.7 \text{ mg/m}^2/\text{year}$.

The results of theoretical calculations are shown in Appendix G.

For the western basin, a theoretical springtime phosphorus concentration of 13.9 mg/m^3 was predicted. This is significantly below the measured range of 23 to 39 mg/m^3 .

For the eastern basin a theoretical springtime phosphorus concentration of 21.4 mg/m^3 was predicted. This is slightly higher than the 17.8 to 20 mg/m^3 range observed since 1975.

As shown, modeling of nutrient input via inflowing streams was only partially successful in estimating phosphorus supplies to Lake Nosbonsing. The model was relatively accurate in its prediction for the eastern basin but it significantly underestimated the nutrient loading to the Astorville basin. The underestimate of phosphorus supply to the western end of the lake could have been the result of a number of factors, of which the most applicable are:

- a) Approximately 58 percent of the eastern basin's watershed was not represented by any of the inflows that were sampled because there are no defined streams in this area. The phosphorus export factor used for this heavily developed area of the watershed was taken as the mean of the export factors for the sub-watersheds of the inflow. This may have provided a low estimate of phosphorus supply.
- b) The once per week sampling of inflows during the spring runoff period may not have been frequent enough to accurately represent the phosphorus supply to the lake. It is possible that periods of high nutrient loading during peak runoff were missed by the sampling frequency used.
- c) Because of the biologically productive character of the Astorville basin, there is the possibility of nutrient recycling and sediment phosphorus release under anaerobic conditions which could develop beneath the ice cover. Coupled with the phosphorus supply of spring runoff, the recycled sediment phosphorus could supplement the inflowing supply resulting in the higher measured springtime values.

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APPENDICES

- APPENDIX A - Results of Chemical Analyses, 1975
- APPENDIX B - Results of Chemical Analyses, 1978
- APPENDIX C - Results of Chemical Analyses, 1979
- APPENDIX D - Results of Surface Water Chemistry,
1975, 1979 and 1980
- APPENDIX E - Dissolved Oxygen and Temperature
Profiles
- APPENDIX F - Results of Chemical Analyses of
Inflowing Streams, 1980
- APPENDIX G - Results of Nutrient Modeling

APPENDIX A: WATER CHEMISTRY OF LAKE NOSBONSING - JUNE 2, 1975

Parameters	Surface Bottom	S B	1	2	Station 3	4	5	6
Hardness	S		24	24	30	25	24	22
	B		-	26	26	26	22	25
Alkalinity	S		15	16	15	15	15	15
	B		-	18	15	15	15	15
pH	S		7.5	7.2	7.2	7.2	7.1	7.0
	B		-	7.0	6.9	7.1	6.9	7.1
Conductivity	S		60	58	53	55	54	54
	B		-	61	54	53	54	54
Total Phosphorus	S		0.025	0.019	0.022	0.021	0.037	0.018
	B		-	0.050	0.031	0.018	0.016	0.017
Total Kjeldahl Nitrogen	S		0.51	0.33	0.49	0.31	0.29	0.35
	B		-	0.48	0.40	0.30	0.33	0.35
Ammonia	S		0.09	0.03	0.01	0.03	0.03	0.03
	B		-	0.18	0.12	0.03	0.06	0.05
Nitrite	S		0.006	0.002	0.002	0.002	0.002	0.002
	B		-	0.005	0.005	0.002	0.002	0.002
Nitrate	S		0.02	<0.01	<0.01	<0.01	0.06	0.01
	B		-	0.04	0.08	<0.01	0.08	0.01
Chloride	S		2.8	2.2	1.1	1.7	1.1	1.1
	B		-	2.3	1.1	1.2	1.1	1.1
Iron	S		0.20	0.10	0.10	0.10	0.30	0.15
	B		-	0.85	0.40	0.40	0.25	0.15

Concentrations in mg/L except pH and conductivity (umhos/cm)

APPENDIX A:

WATER CHEMISTRY OF LAKE NOSBONSING - JULY 2, 1975

Parameters	Surface S	1	2	Station 3	4	5	6
	Bottom B						
Hardness	S	24	24	23	24	21	23
	B	-	24	22	24	26	24
Alkalinity	S	16	15	15	16	15	15
	B	-	21	19	16	16	18
pH	S	7.7	7.2	7.4	7.2	7.2	7.1
	B	-	6.8	6.9	7.3	6.6	6.6
Conductivity	S	67	60	57	56	57	56
	B	-	69	60	58	58	63
Total Phosphorus	S	0.019	0.013	0.011	0.010	0.012	0.013
	B	-	0.074	0.080	0.011	0.017	0.024
Total Kjeldahl Nitrogen	S	0.40	0.32	0.28	0.27	0.31	0.30
	B	-	0.63	0.64	0.27	0.27	0.38
Ammonia	S	0.04	0.03	0.02	0.02	0.02	0.03
	B	-	0.33	0.26	0.02	0.05	0.06
Nitrite	S	0.002	0.001	0.001	<0.001	0.001	0.001
	B	-	0.003	0.008	<0.001	0.002	0.001
Nitrate	S	<0.01	<0.01	<0.01	<0.01	0.05	<0.01
	B	-	<0.01	0.03	<0.01	<0.01	<0.01
Chloride	S	2.6	2.2	1.2	1.2	1.2	1.3
	B	-	2.4	1.2	1.2	1.2	1.2
Iron	S	0.15	0.05	0.05	0.05	0.05	0.05
	B	-	1.2	1.8	0.05	0.27	0.75

* Concentrations in mg/L except pH and conductivity (umhos/cm)

APPENDIX A:

WATER CHEMISTRY OF LAKE NOSBONSING - AUGUST 19, 1975

Parameters	Surface S Bottom B	1	2	Station 3	4	5	6
Hardness	S B	23 -	29 24	22 22	22 22	22 22	22 27
Alkalinity	S B	17 -	23 23	17 17	17 17	12 11	12 16
pH	S B	6.8 -	7.5 7.5	7.0 6.8	7.1 6.9	7.3 7.1	7.2 7.5
Conductivity	S B	63 -	66 72	58 57	60 60	59 57	58 68
Total Phosphorus	S B	0.037 -	0.036 0.220	0.034 0.024	0.042 0.047	0.041 0.038	0.027 0.027
Total Kjeldahl Nitrogen	S B	0.66 -	0.70 1.4	0.68 0.48	0.77 0.73	0.59 0.52	0.60 0.55
Ammonia	S B	0.15 -	0.14 0.60	0.18 0.13	0.17 0.23	0.17 0.07	0.10 0.16
Nitrite	S B	0.003 -	0.002 0.004	0.002 0.006	0.003 0.003	0.003 0.004	0.003 0.003
Nitrate	S B	<0.01 -	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01
Chloride	S B	2.5 -	2.2 2.6	1.4 1.4	1.4 1.4	1.3 1.4	1.4 1.4
Iron	S B	0.17 -	0.06 2.10	0.10 0.09	0.10 0.07	0.08 0.11	0.09 0.09

* Concentrations in mg/L except pH and conductivity (umhos/cm)

APPENDIX B:

WATER CHEMISTRY OF LAKE NOSBONSING - AUGUST 22, 1978

Parameters	Surface S Bottom B	1	2	Station 3	4	5	6
Hardness	S	22	22	23	23	23	23
	B	-	22	24	25	25	23
Alkalinity	S	17	17	18	18	18	18
	B	-	17	24	20	22	18
pH	S	7.71	7.59	7.31	7.29	7.34	7.14
	B	-	7.28	6.73	6.95	6.84	7.24
Conductivity	S	64	62	60	59	59	60
	B	-	62	67	64	66	59
Total Phosphorus	S	0.025	0.020	0.016	0.026	0.016	0.020
	B	-	0.022	0.172	0.060	0.066	0.013
Total Kjeldahl Nitrogen	S	0.53	0.45	0.30	0.33	0.32	0.30
	B	-	0.47	0.68	0.44	0.48	0.32
Ammonia	S	0.069	0.056	0.019	0.013	0.017	0.017
	B	-	0.056	0.291	0.116	0.170	0.096
Nitrite	S	0.002	0.002	0.002	0.002	0.002	0.002
	B	-	0.002	0.004	0.000	0.006	0.002
Nitrate	S	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	B	-	<0.005	<0.005	0.010	<0.005	<0.005
Organic Carbon	S	6.0	5.2	4.8	4.9	4.8	5.1
	B	-	5.4	5.3	5.2	5.4	5.2
Inorganic Carbon	S	3.5	5.6	3.8	3.8	3.7	4.0
	B	-	3.6	6.1	4.7	5.2	3.8

Chemical Water Quality - Nosbonsing Lake (Continued)

Calcium	S	5.8	5.8	6.0	6.0	6.0	6.2
	B	-	5.8	6.6	6.4	6.6	6.0
Magnesium	S	1.85	1.85	1.85	1.85	1.85	1.85
	B	-	1.90	1.90	1.95	2.0	1.90
Sulfate	S	7.5	8.5	8.5	8.0	7.5	7.5
	B	-	8.0	10.0	8.5	8.5	8.5
Chloride	S	3.1	2.7	1.4	1.4	1.4	1.4
	B	-	2.7	1.4	1.4	1.4	1.4
Iron	S	0.14	0.06	0.13	0.12	0.08	0.14
	B	-	0.12	3.70	0.94	1.00	0.09
Colour	S	33	21	21	20	20	22
	B	-	20	92	52	54	17

*Concentrations in mg/L except pH, conductivity (umhos/cm) and colour (Hazen units).

APPENDIX C:

WATER CHEMISTRY OF LAKE NOSBONSING - JUNE 20, 1979

Parameters	Surface S Bottom B	1	2	Station 3	4	5	6
Hardness	S	21	21	20	20	20	19
	B	-	21	21	21	21	20
Alkalinity	S	17	16	17	17	17	17
	B	-	18	20	17	17	16
pH	S	7.17	7.32	7.42	7.37	7.50	7.44
	B	-	6.72	6.78	7.31	6.95	7.04
Conductivity	S	63	63	57	57	56	57
	B	-	68	63	57	58	57
Total Phosphorus	S	0.025	0.020	0.034	0.024	0.018	0.016
	B	-	0.063	0.068	0.025	0.033	0.019
Total Kjeldahl Nitrogen	S	0.50	0.46	0.36	0.39	0.34	0.33
	B	-	0.66	0.68	0.37	0.36	0.40
Ammonia	S	0.031	0.026	0.006	0.008	0.005	0.005
	B	-	0.272	0.337	0.011	0.034	0.014
Nitrite	S	0.001	0.001	0.001	0.001	0.001	0.001
	B	-	0.003	0.004	0.002	0.001	0.001
Nitrate	S	0.004	0.004	0.004	0.004	0.004	0.004
	B	-	0.027	0.021	0.003	0.009	0.004
Chloride	S	3.55	3.20	1.50	1.50	1.50	1.50
	B	-	3.40	1.50	1.50	1.50	1.50
Iron	S	0.15	0.07	0.08	0.10	0.08	0.08
	B	-	0.60	1.3	0.10	0.58	0.15

*Concentrations mg/L except pH and conductivity (umhos/cm).

APPENDIX C: WATER CHEMISTRY OF LAKE NOSBONSING - AUGUST 29, 1979

Parameters	Surface Bottom	S B	1	2	Station 3	4	5	6
Hardness	S B		22	22 25	23 22	23 22	22 23	22 22
Alkalinity	S B		19	18 28	20 20	20 19	19 19	20 20
Conductivity	S B		65	64 79	62 60	62 60	60 61	62 60
Total Phosphorus	S B		0.024	0.025 0.270	0.030 0.018	0.048 0.020	0.029 0.073	0.036 0.051
Total Kjeldahl Nitrogen	S B		0.52	0.61 1.93	0.75 0.35	0.49 0.38	0.63 0.45	0.60 0.41
Ammonia	S B		0.033	0.019 0.738	0.043 0.057	0.031 0.043	0.022 0.110	0.036 0.048
Nitrite	S B		0.001	0.001 0.003	0.001 0.001	0.001 0.002	0.001 0.002	0.001 0.001
Nitrate	S B		<0.005	<0.005 0.002	<0.005 0.009	<0.005 0.009	<0.005 0.013	<0.005 0.004
Organic Carbon	S B		5.3	5.3 5.4	5.4 4.3	4.7 4.4	5.2 4.4	5.3 4.4
Inorganic Carbon	S B		3.4	2.2 9.2	2.0 4.0	3.0 3.8	2.6 4.2	2.8 5.2

Water Chemistry of Nosbonsing Lake August 29, 1979 (Continued)

Calcium	S	6.2	6.2	6.4	6.4	6.2	6.2
	B		7.2	6.4	6.2	6.4	6.0
Magnesium	S	1.70	1.60	1.60	1.60	1.60	1.55
	B		1.75	1.55	1.60	1.60	1.70
Chloride	S	3.05	2.75	1.45	1.40	1.40	1.45
	B		3.20	1.40	1.40	1.40	1.45
Sulphate	S	7.5	8.0	8.0	8.0	8.0	8.0
	B		7.0	8.5	8.0	8.5	7.5
Iron	S	0.17	0.09	0.19	0.10	0.09	0.09
	B		3.4	0.12	0.16	0.36	0.18

* Concentrations in mg/L except conductivity (umhos/cm).

APPENDIX D:

SURFACE WATER CHEMISTRY OF LAKE NOSBONSING
MAY 21/75

PARAMETER	STATION				
	1	2	3	4	5
Hardness	23	22	21	22	20
Alkalinity	16	15	15	17	14
pH	6.7	7.0	7.3	7.4	7.3
Conductivity	60	58	54	57	54
Total Phosphorus	0.026	0.026	0.015	0.018	0.016
Total Kjeldahl Nitrogen	0.60	0.87	0.35	0.30	0.29
Nitrite	0.001	0.001	0.003	0.003	0.002
Nitrate	<0.01	<0.01	<0.01	<0.01	<0.01
Inorganic Carbon	3	3	3	3	3
Colour	15	15	15	15	20

*Concentrations in mg/L except pH and conductivity (umhos/cm).

Colour in Hazen Units.

APPENDIX D:

SURFACE WATER CHEMISTRY OF LAKE NOSBONSING
MAY 24, 1979

PARAMETERS	STATION	1	2	4	6
Hardness		22	21	21	21
Alkalinity		16	16	16	17
pH		6.95	6.90	7.09	6.90
Conductivity		66	64	57	57
Total Phosphorus		0.023	0.023	0.017	0.017
Total Kjeldahl Nitrogen		0.46	0.47	0.36	0.34
Ammonia		0.060	0.093	0.048	0.056
Nitrite		0.002	0.002	0.001	0.001
Nitrate		0.003	0.013	0.004	0.014
Organic Carbon		5.1	4.6	4.4	4.5
Inorganic Carbon		3.4	3.6	3.6	3.8
Calcium		6.0	5.8	5.8	5.8
Magnesium		1.70	1.65	1.55	1.55
Chloride		1.90	2.20	1.45	1.40
Sulphate		9.5	9.0	9.0	9.0
Colour		28	25	21	25

*Concentrations in mg/L except pH, conductivity (umhos/cm) and colour (Hazen units).

APPENDIX D:

SURFACE WATER CHEMISTRY OF LAKE NOSBONSING
MAY 19, 1980

PARAMETERS	STATION 1	2	4	6
Hardness	19	19	20	19
Alkalinity	15	18	16	16
pH	7.05	7.1	7.1	7.1
Conductivity	65	60	55	55
Total Phosphorus	0.034	0.044	0.019	0.022
Total Kjeldahl Nitrogen	0.56	0.51	0.38	0.46
Ammonia	0.104	0.100	0.062	0.092
Nitrite	0.002	0.002	0.003	0.004
Nitrate	0.003	0.003	0.042	0.016
Organic Carbon	5.6	4.8	4.6	4.7
Inorganic Carbon	3.8	4.2	3.8	4.0
Calcium	5.0	5.2	5.6	5.4
Magnesium	1.55	1.5	1.4	1.5
Chloride	3.95	3.10	1.45	1.4
Sulphate	7.5	7.5	7.5	8.5
Colour	32	20	25	29

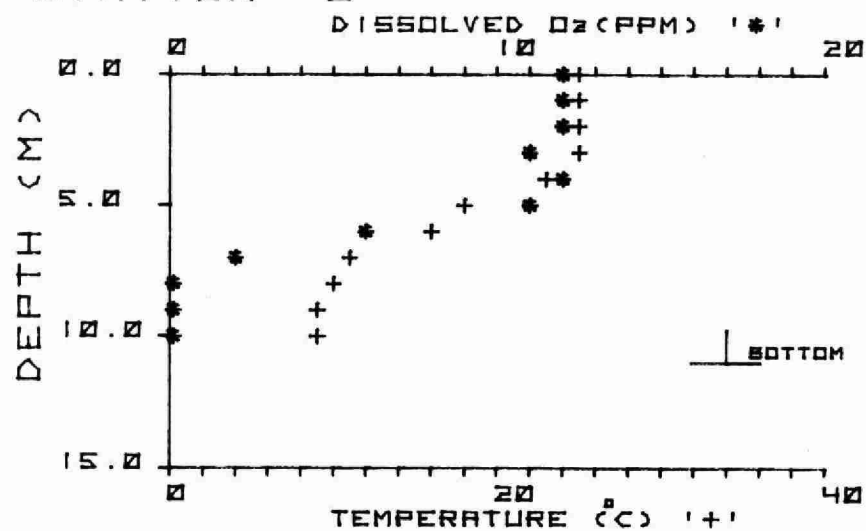
*Concentrations in mg/L except pH, conductivity (umhos/cm) and colour (Hazen units).

NOSBONING

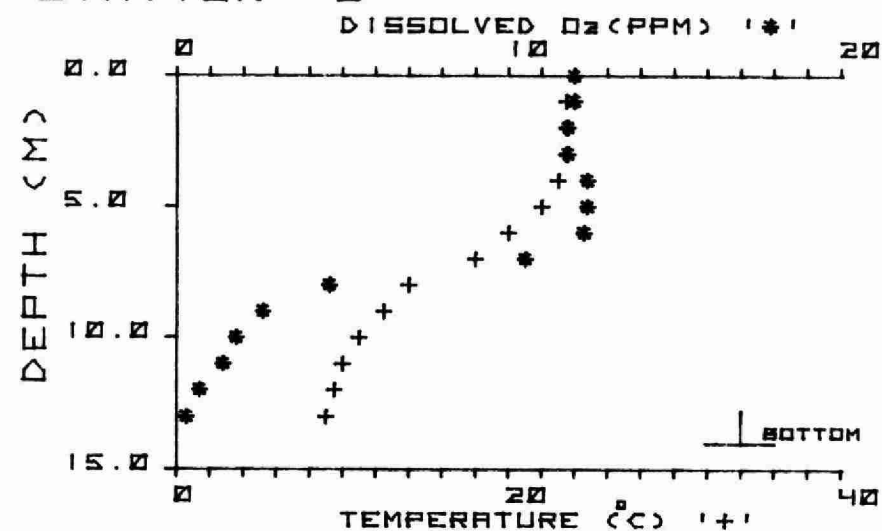
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JULY 2/75

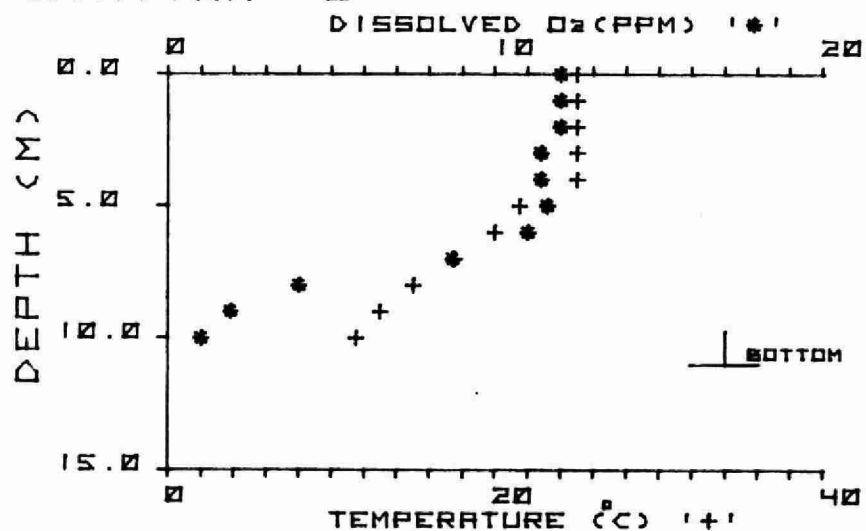
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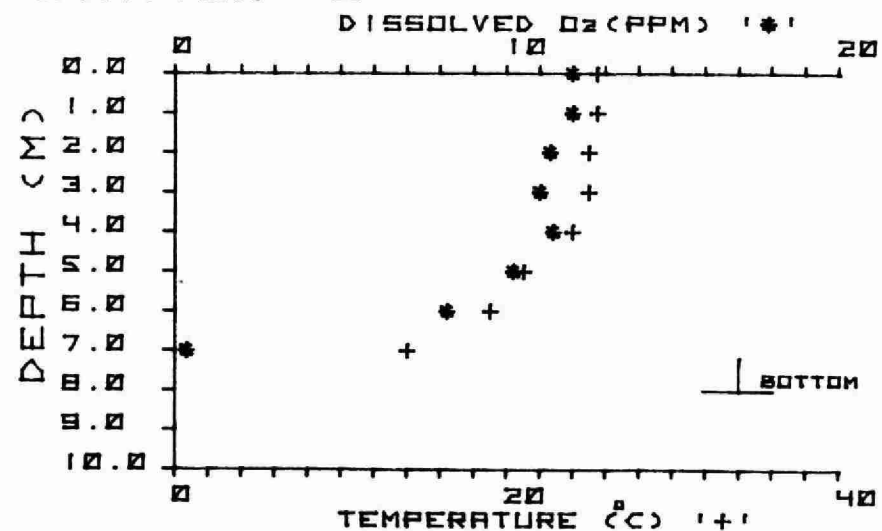
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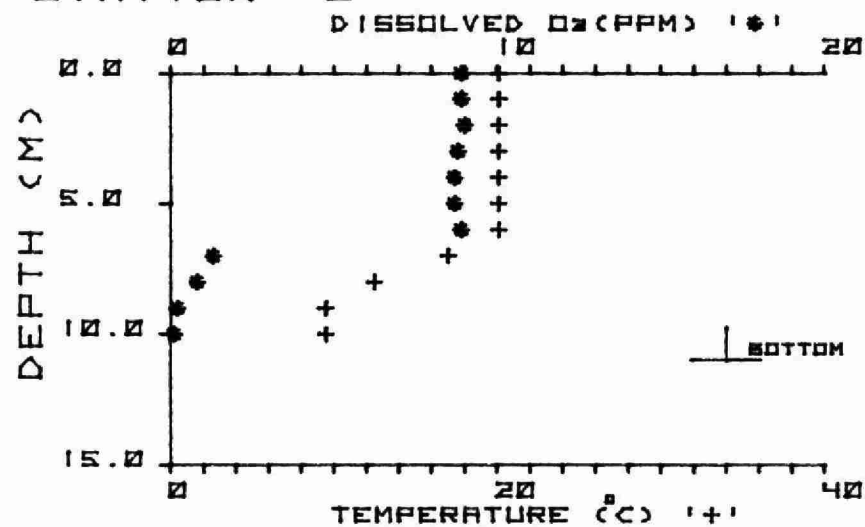
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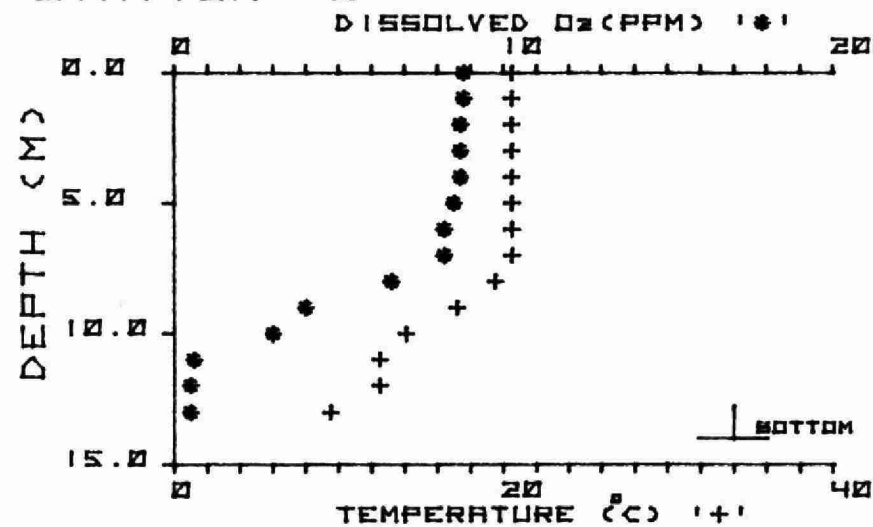
NOSBONSING NORTHEASTERN REGION - M.O.E.

AUG. 19/75

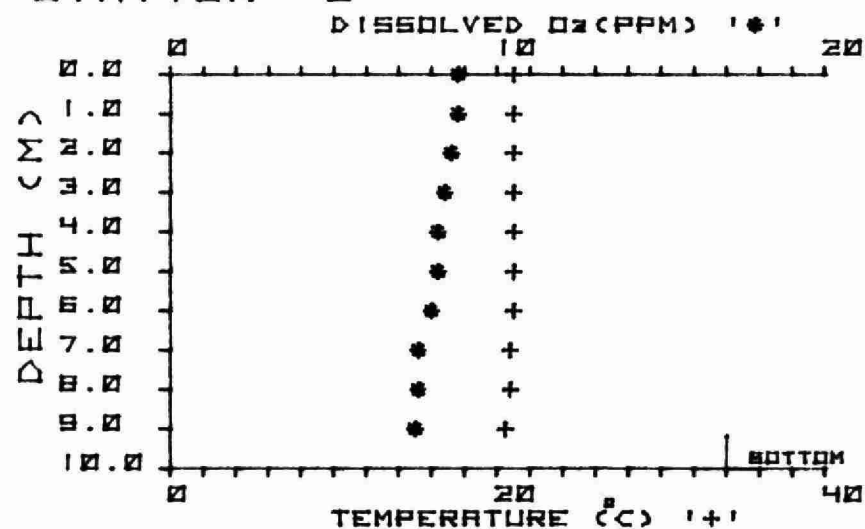
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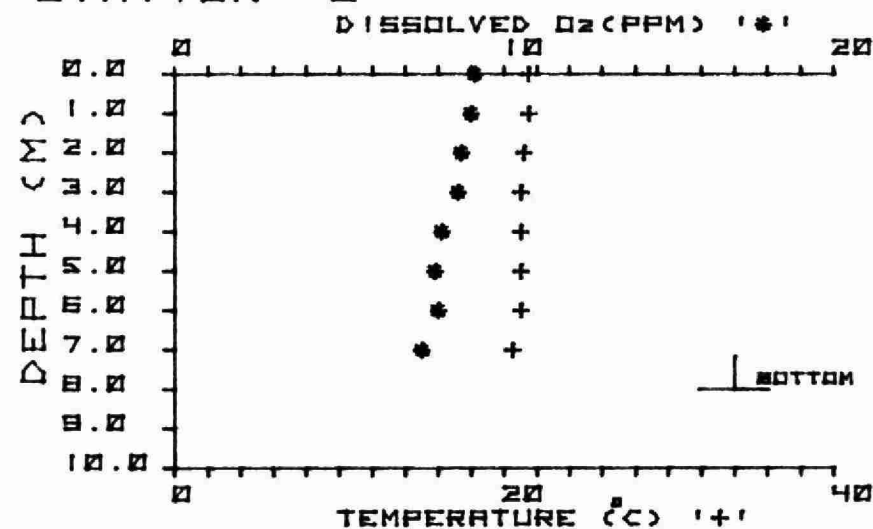
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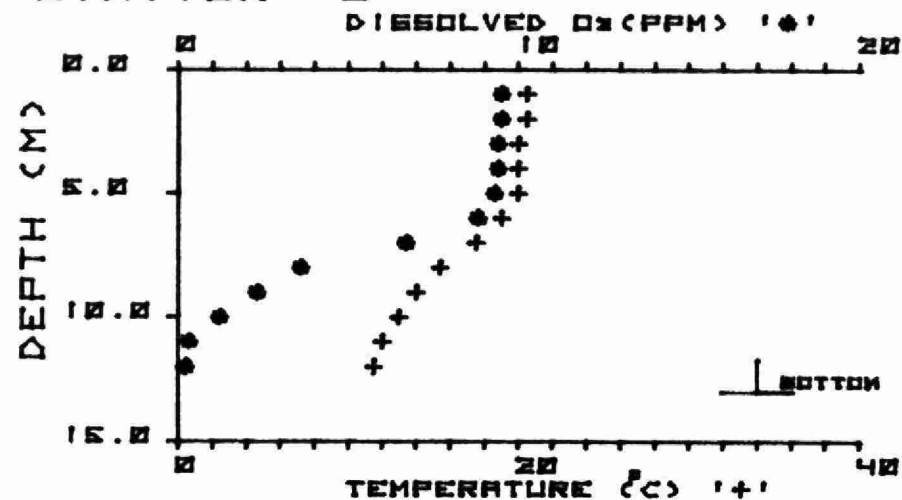


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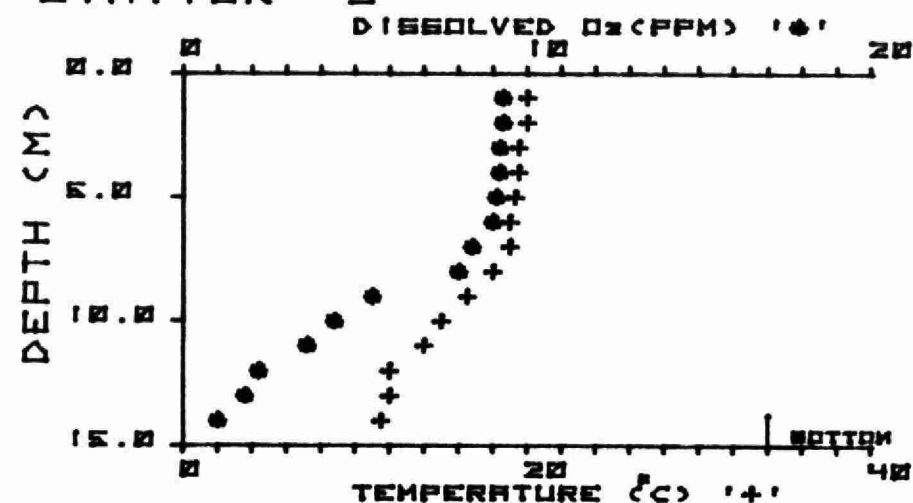
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JUNE 20/79

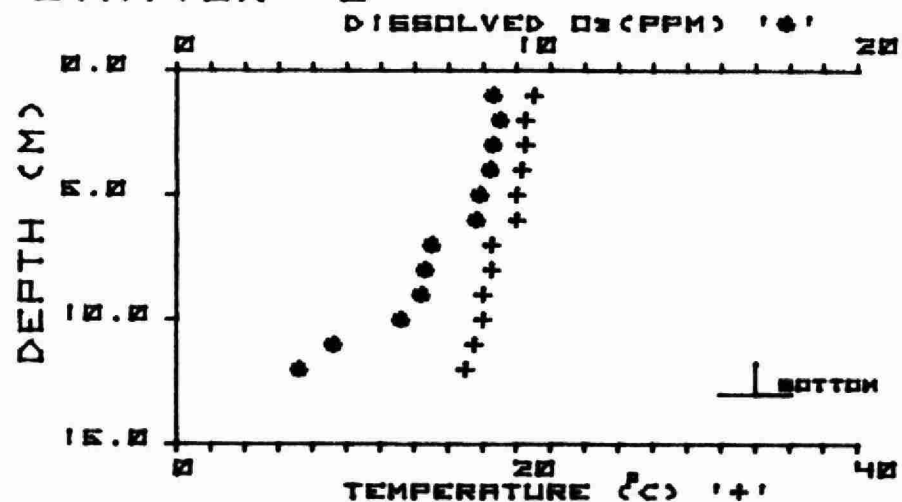
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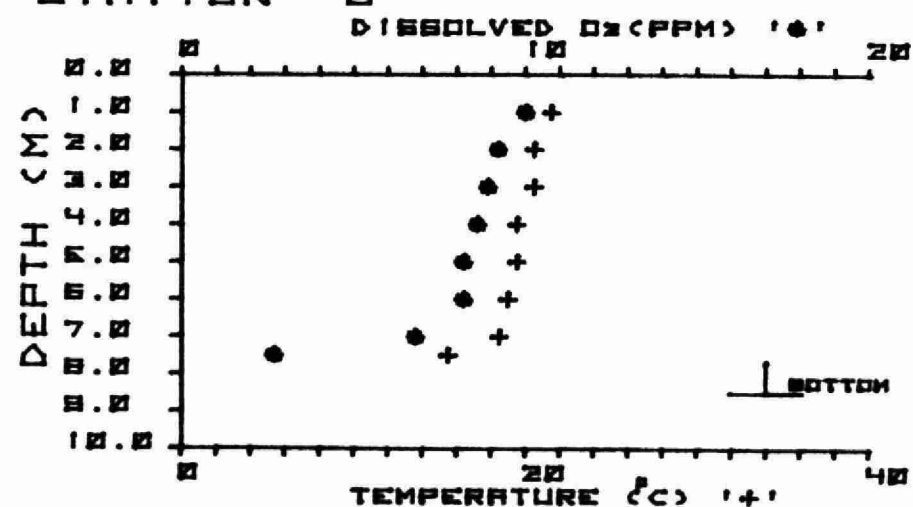
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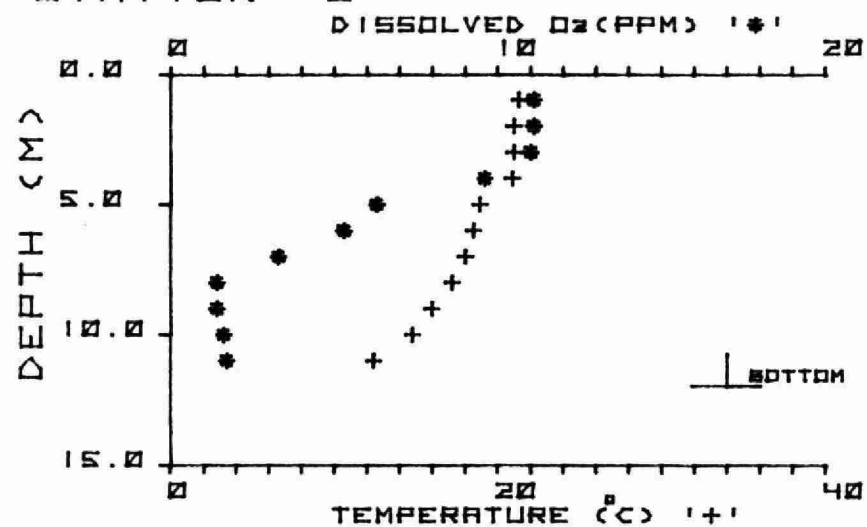


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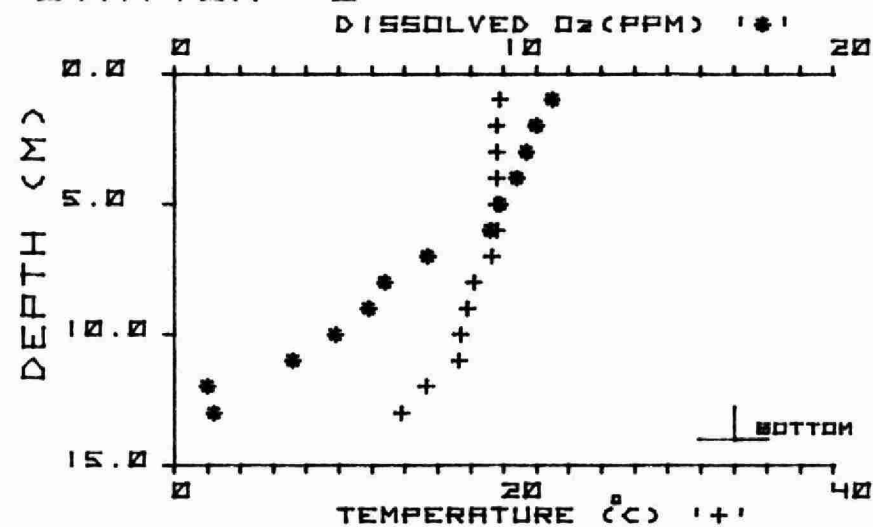
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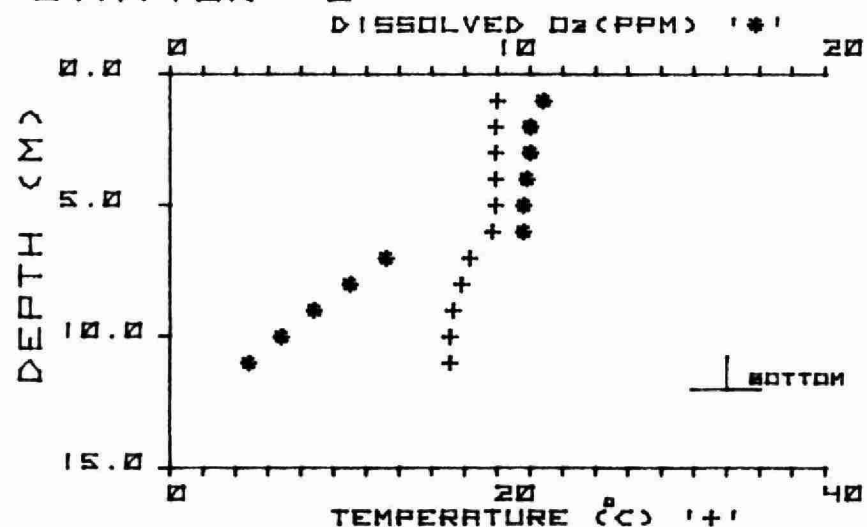
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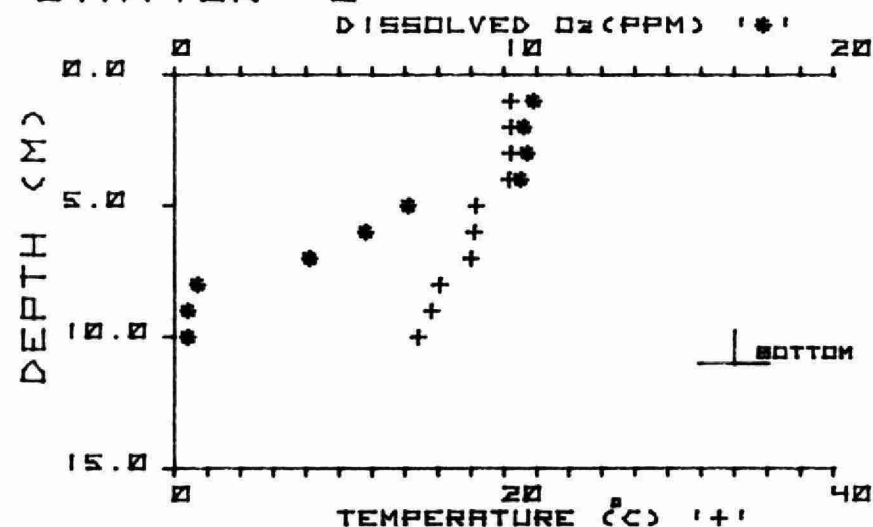
STATION 3



STATION 5



STATION 6



APPENDIX F:

LAKE NOSBONSING INFLOW MONITORING 1980

<u>STATION</u>	<u>HARDNESS</u>	<u>ALKALINITY</u>	<u>CALCIUM</u>	<u>MAGNESIUM</u>	<u>SULPHATE</u>	<u>CHLORIDE</u>	<u>TOTAL PHOS.</u>	<u>REACTIVE PHOS.</u>
NL-1 R	12 - 30	9 - 17	3 - 7.6	1 - 2.7	8.5 - 16.5	5.6 - 20.5	.026 - .108	.003 - 0 .020
M	25	14	6.4	2.2	12.8	15.0	.064	.012
NL-2 R	8 - 30	7 - 28	2 - 7.8	.8 - 2.6	7 - 13	.7 - 5.4	.028 - .108	.001 - .024
M	21	14	5.5	1.8	10.7	3.1	.058	.010
NL-3 R	10 - 19	9 - 16	2.4 - 4.8	.90 - 1.8	8.0 - 13.5	.40 - .80	.62 - .140	.011 - .020
M	15	12	3.9	1.4	11	.60	.096	.014
NL-4 R	10	7	2.6	.75	9.0	.55	.060	.011
NL-5 R	12 - 18	8 - 16	3.4 - 5.0	.90 - 1.5	7.0 - 10.5	.40 - .80	.018 - .033	.001 - .003
M	14.5	11.6	4.0	1.2	8	.56	.025	.001
NL-6 R	10 - 28	8 - 25	3 - 8.2	.55 - 2.0	8.0 - 11.5	.40 - .75	.018 - .375	.001 - .003
M	20	17	5.8	1.5	10.1	.56	.083	.002
NL-7 R	16 - 17	18 - 19	2.6 - 3.6	.45 - 1.8	6.0 - 10	2.1 - 3.3	.058 - .085	.008
M	17	19	3.1	1.1	8.0	2.7	.071	.008
NL-8 R	8 - 19	6 - 17	2.6 - 5.6	.45 - 1.5	6.0 - 10.5	.15 - .70	.015 - .060	.001 - .007
M	14	11	4.1	1.0	8.5	.45	.024	.003
NL-9 R	7 - 23	7 - 14	2.2 - 6.6	.40 - 1.7	6.0 - 12.0	.50 - 3.1	.019 - .085	.001 - .007
M	15	10	4.3	1.1	11	.78	.033	.003

APPENDIX F: (continued)

<u>STATION</u>		<u>pH</u>	<u>CONDUCT.</u>	<u>COLOUR</u>	<u>AMMONIA</u>	<u>KJELDAHL NITROGEN</u>	<u>NITRATE</u>	<u>NITRITE</u>	<u>IRON</u>	<u>SUSPENDED SOLIDS</u>
NL-1	R	6.2 - 6.7	60 - 135	33 - 63	0.44 - 2.54	.52 - .84	.005 - .013	.235 - .522	.21 - 1.2	3 - 23
	M	6.4	112	47	.150	.69	.010	.480	8.3	11
NL-2	R	6.0 - 7.3	38 - 82	56 - 136	.022 - .134	.44 - 1.2	.004 - .012	.005 - .601	.76 - 3.5	7 - 76
	M	6.8	62	85	.063	.77	.007	.110	1.7	29
NL-3	R	6.0 - 6.8	35 - 55	62 - 77	.026 - .166	.75 - .83	.005 - .008	.018 - .084	.90 - 4.5	19 - 76
	M	6.4	47	70	.099	.80	.007	.054	2.1	43
NL-4	R	5.9	33	59	.106	.58	.005	.105	1.5	31
NL-5	R	6.0 - 7.2	36 - 55	38 - 76	.030 - .370	.32 - .78	.002 - .008	.003 - .299	.20 - .85	4 - 7
	M	6.6	43	48	.098	.57	.004	.077	.43	4
NL-6	R	6.2 - 7.4	32 - 70	33 - 87	.014 - .168	.27 - .72	.003 - .005	.005 - .191	.74 - 8.6	6 - 168
	M	6.9	55	53	.057	.44	.004	.077	2.1	47
NL-7	R	6.5 - 6.6	55 - 72	11 - 73	.150 - .294	.84 - 1.3	.008 - .009	.107 - .276	.98 - 2.6	12 - 13
	M	6.5	64	42	.222	1.1	.008	.191	1.8	13
NL-8	R	6.2 - 7.1	29 - 45	33 - 92	.002 - .174	.29 - .65	.002 - .004	.005 - .106	2.4 - 2.6	1 - 34
	M	6.7	41	46	.055	.44	.003	.029	.72	7
NL-9	R	6.3 - 7.0	27 - 60	46 - 92	.008 - .232	.36 - .68	.003 - .007	.001 - .231	.64 - 4.0	3 - 73
	M	6.7	44	62	.065	.47	.005	.074	1.2	16

*R = Range

M = Mean

Concentrations in mg/L except pH (pH units), conductivity (umhos/cm) and colour (Hazen units).

APPENDIX G: RESULTS OF NUTRIENT MODELING

ONTARIO MINISTRY OF THE ENVIRONMENT - NORTHEAST REGION

LAKE DEVELOPMENT CAPACITY - DILLON'S MODEL

LAKE: Nosbonsing
TWP.: Bonfield
DATE: DEC 1982

SUPPORTING DATA:

Lake Area(sq.m): 13564490
Drainage Area(sq.m): 120870898
Mean Depth(m): 5.50
Volume(cu.m): 74604695
Unit Runoff(m/yr): 0.4490
Precipitation(m/yr): 0.89
Evaporation(m/yr): 0.56
Total Outflow Volume(cu.m): 59944893
Flushing Rate(Lake's vol./yr): 0.8035
Retention Coefficient(R): 0.7492
Response Time(yr): 0.6 to 1.1

Actual Phosphorus Loading(mg/sq.m/yr): Not available(theoretical estimate was used in calculations)
Actual Phosphorus Supply(kg/yr): Not available(theoretical estimate was used in calculations)

MEASURED SPRING PHOSPHORUS CONCENTRATION(mg/cu.m): Not available(theoretical estimate was used in calculations)

Theoretical Phosphorus Loading(mg/sq.m/yr): 376.27
Theoretical Phosphorus Supply(kg/yr): 5103.92

THEORETICAL SPRING PHOSPHORUS CONCENTRATION(mg/cu.m): 21.4

APPENDIX C: (continued)

ONTARIO MINISTRY OF THE ENVIRONMENT - NORTHEAST REGION

LAKE DEVELOPMENT CAPACITY - DILLON'S MODEL

LAKE: Nosbonsing-West

TWP.: Bonfield

DATE: DEC 1982

SUPPORTING DATA:

Lake Area(sq.m): 3629025

Drainage Area(sq.m): 12741910

Mean Depth(m): 5.00

Volume(cu.m): 18145125

Unit Runoff(m/yr): 0.4490

Precipitation(m/yr): 0.89

Evaporation(m/yr): 0.56

Total Outflow Volume(cu.m): 6918696

Flushing Rate(Lake's vol./yr): 0.3813

Retention Coefficient(R): 0.8738

Response Time(yr): 0.7 to 1.1

Actual Phosphorus Loading(mg/sq.m/yr): Not available(theoretical estimate was used in calculations)

Actual Phosphorus Supply(kg/yr): Not available(theoretical estimate was used in calculations)

MEASURED SPRING PHOSPHORUS CONCENTRATION(mg/cu.m): Not available(theoretical estimate was used in calculations)

Theoretical Phosphorus Loading(mg/sq.m/yr): 209.25

Theoretical Phosphorus Supply(kg/yr): 759.37

THEORETICAL SPRING PHOSPHORUS CONCENTRATION(mg/cu.m): 13.9

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